EUROPEAN PATENT APPLICATION

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(54) Optical module.

(57) An optical module comprises an optical connector (R) at the receiver side and an optical connector (T) at the transmitter side, and hybrid IC's (23, 24) for the receiver side and the transmitter side are mounted on a lead frame (3). The lead frame (3) comprises a projecting part (3e) projecting outside from a part where each hybrid IC (23; 24) is mounted. Nearby the connection part between the optical connector (R; T) and the hybrid IC (23; 24), the projecting part (3e) is connected to a ground pattern (S) on a surface of the hybrid IC by a bonding wire (4). The wire (4) is placed at this location, so that the effect of noise caused by an atmospheric electric wave, or GND/power lines can be reduced.

EP 0 624 962 A2

Fig. 14
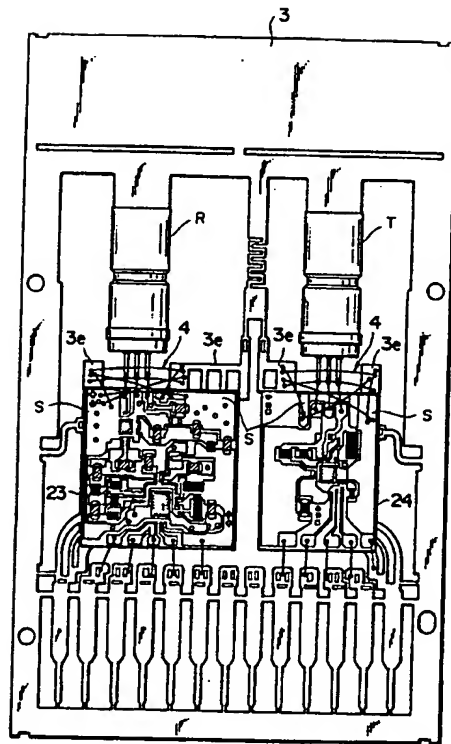
BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to an optical module which is sealed by mold material.

Related Background Art

In recent years, packaging techniques for semiconductor integrated circuits have made great progress and various kinds of electronic parts are packaged with high density. Therefore, it is an important subject to reduce noises caused by the adjacent electronic parts. In general, a noise source is an atmospheric electric wave generated by the adjacent electronic parts, a noise of power source through GND/power lines or others. In particular, countermeasure for the noises is important for an optical module which converts a feeble optical signal into an electric signal.

In the conventional optical modules, for certain electronic parts installed inside, a metal shielding board was installed or instead of the electronic parts, other circuit parts for reducing noise were mounted.

However, in such shielding structure in which the electronic parts were shielded, a shielding member larger than the electronic parts was installed, and in particular, in a case that shielding was required on a same substrate, a region occupied by the shielding member on the substrate was substantially large. This hindered the advance of miniaturizing a module.

For the electronic parts, an additional process of installing the shielding member was required, which caused both an increase of the number of processes of manufacturing the optical module and a fall of the productive efficiency.

Further, there was a practical problem that in the resin molding type products, the shielding member was broken by the stress when resin was poured.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide an optical module which can reduce the effect of noise caused by an atmospheric electric wave or GND/power lines without reducing the mounting density of the circuit substrate which constitutes the optical module.

It is another object of the present invention to provide an optical module with a configuration which hardly receives the stress when the resin is poured.

It is another object of the present invention to provide an optical module at low cost and with good productivity.

The above and other objects will be apparent from the following description.

According to the present invention, an optical module sealed by mold material is provided. This optical module comprises a light receiving device for converting an optical signal into an electric signal, a first substrate comprising a circuit which is electrically connected to an output terminal of the light receiving device through a signal connecting wire, for processing an electric signal coming from the output terminal, a mounting substrate for mounting said first substrate, and a conductive wire placed nearby a connection part between the optical connector and the first substrate without contacting said signal connecting wire. The mounting substrate comprises a first reference potential region which is of a part of the mounting substrate, projecting outside from a part where the first substrate is mounted. The first substrate comprises a second reference potential region on a surface of the first substrate, which is electrically connected to the mounting substrate, and one end of the conductive wire is connected to one of the first reference potential region and the second reference potential region, and the other end of the conductive wire is connected to one of the first reference potential region and the second reference potential region.

Further, according to the present invention, an optical module sealed by mold material is provided. This optical module comprises a first optical connector comprising a light receiving device for converting an optical signal into an electric signal, a first substrate comprising a circuit which is electrically connected to an output terminal of the light receiving device through a first signal connecting wire, for processing an electric signal coming from the output terminal, a first mounting substrate for mounting the first substrate, a second optical connector comprising a light emitting device for converting an electric signal into an optical signal, a second substrate comprising a circuit which is electrically connected to an input terminal of the light emitting device through a second signal connecting wire, for applying an electric signal to the input terminal, a second mounting substrate for mounting the second substrate, electrically connected to the first mounting substrate, and a conductive wire is placed nearby a connection part between the first optical

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connector and the first substrate without contacting the first signal connecting wire. The first mounting substrate comprises a first reference potential region which is of a part of the first mounting substrate, projecting outside from a part where the first substrate is mounted, and the first substrate comprises a second reference potential region on a surface of the first substrate, which region is electrically connected to the first mounting substrate. One end of the conductive wire is connected to one of the first reference potential region and the second reference potential region, and the other end of the conductive wire is connected to one of the first reference potential region and the second reference potential region.

Moreover, according to the present invention, an optical module sealed by mold material is provided. This optical module comprises a first optical connector comprising a light receiving device for converting an optical signal into an electric signal, a first substrate comprising a circuit which is electrically connected to an output terminal of the light receiving device through a first signal connecting wire, for processing an electric signal coming from the output terminal, a first mounting substrate for mounting the first substrate, a second optical connector comprising a light emitting device for converting an electric signal into an optical signal, a second substrate comprising a circuit which is electrically connected to an input terminal of the light emitting device through a second signal connecting wire, for applying an electric signal to the input terminal, a second mounting substrate for mounting the second substrate electrically connected to the first mounting substrate, a first conductive wire placed nearby a connection part between the first optical connector and the first substrate without contacting the first signal connecting wire, and a second conductive wire placed nearby a connection part between the second optical connector and the second substrate without contacting the second signal connecting wire. The first mounting substrate comprises a first reference potential region which is of a part of the first mounting substrate, projecting outside from a part where the first substrate is mounted, and the first substrate comprises a second reference potential region on a surface of the first substrate, which region is electrically connected to the first mounting substrate. One end of the first conductive wire is connected to one of the first reference potential region and the second reference potential region, and the other end of the first conductive wire is connected to one of the first reference potential region and the second reference potential region. The second mounting substrate comprises a third reference potential region which is of a part of the second mounting substrate, projecting outside from a part where the second substrate is mounted, and the second substrate comprises a fourth reference potential region on a surface of the second substrate, which region is electrically connected to the second mounting substrate. One end of the second conductive wire is connected to one of the third reference potential region and the fourth reference potential region, and the other end of the second conductive wire is connected to one of the third reference potential region and the fourth reference potential region.

Here, each conductive wire is preferably a bonding wire or a flat ribbon wire, and further a plurality of conductive wires may be provided.

Further, each mounting substrate is preferably constructed with a part of the lead frame.

Further, the potential applied to each reference potential region is preferably a ground potential.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a perspective view showing an optical module (sub- module) before molding.

Fig. 2 is a plane view showing an optical module of Fig. 1.

Fig. 3 is a plane view showing a region sealed by mold material.

Fig. 4 is a perspective view showing an optical module before unnecessary parts of a lead frame are cut off.

Fig. 5 is a perspective view showing an optical module after unnecessary parts of a lead frame are cut off.

Fig. 6 is a vertical sectional view of an optical module shown in Fig. 5.

Fig. 7 is a perspective view showing another embodiment of an optical module before molding.

Fig. 8 is a plane view showing an optical module of Fig. 7.

Fig. 9 is a plane view showing the condition that one conductive wire is installed at each of the transmitter side and the receiver side.

Fig. 10 is a plane view of an optical module showing the condition that two conductive wires are installed at each of the transmitter side and the receiver side.

Fig. 11 is a plane view showing the condition that one conductive wire is installed at each of the transmitter side and the receiver side.

Fig. 12 is a plane view of an optical module showing the condition that two conductors are installed at each of the transmitter side and the receiver side.

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Fig. 13 is a graph of this showing a measurement result.

Fig. 14 is a plane view of an optical module showing the condition of another conductive wire.

Fig. 15 is a plane view of an optical module showing the condition of another conductive wire.

Fig. 16 is a plane view showing another embodiment of an optical module.

Fig. 17 is a plane view showing another embodiment of an optical module.

Fig. 18 is a schematic plane view showing the main points of the optical module which was used in the measurement.

Figs. 19A to 19I are schematic plane views showing the locations of the conductive wires on the optical modules which were used in each of the measurements.

Fig. 20 is a partially perspective view showing the optical module shown in Fig.19D.

Fig. 21 is schematic perspective view showing an another embodiment of conductive wires.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The preferred embodiments of the present invention which was used in the measurement, will be explained with reference to the accompanying drawings hereunder.

First Embodiment

An optical module according to the present embodiment is shown in Fig. 1. The optical module shown in Fig. 1 is for a large-scale link and comprises an optical connector R comprising a light receiving device 21 and an optical connector T comprising a light emitting device 22. An output terminal of the light receiving device 21 is connected to a hybrid IC 23 comprising a circuit for processing an electric signal coming from the output terminal, through wires (signal connecting wires) 2. An input terminal of the light emitting device 22 is connected to a hybrid IC 24 comprising a circuit for controlling the light emission for applying electric signals to the input terminal, through the wires 2.

The optical connectors R and T, and the hybrid IC 23 and 24 are fixed at a conductive lead frame 3. The lead frame 3 comprises island parts 3a for mounting the hybrid ICs 23 and 24, a frame part 3b surrounding the parts 3a, a support part 3c in the center, lead pins 3d, and connection parts (reference potential regions) 3e. The connection parts 3e are formed, projecting from the both sides of the connection region between the optical connector R and the semiconductor chip 23, and from the both sides of the connection region between the optical connector T and the semiconductor chip 24. Then, between the connection parts 3e, a conductive wire 4 made of a bonding wire is installed across the wires 2. The conductive wire 4 is made of a 150 μm diameter Al wire.

It was found that the noise level could be reduced to some extent, which will be described in detail, by placing the conductive wires 4 nearby the connection region as described above. This seems to be because the atmospheric electric wave generated by the adjacent electronic parts is shielded to some extent and because the GND strengthens.

Further, ground patterns (reference potential region) S on the surfaces of the hybrid ICs 23 and 24 are electrically connected with the island parts 3a of the lead frame 3 through a large number of through-holes. In a case that the GND potential is applied to the island part 3a, the GND potential is also applied to the ground pattern S. Accordingly, the conductive wire 4 as described above can be connected to the ground pattern S. Further, certain electrode regions of the hybrid IC 23 and 24 are electrically connected with the lead pins 3d of the lead frame 3 through the wires 2.

The important circuit devices on the hybrid ICs 23 and 24 are shown in Fig. 2. It is convenient to omit wires for connection and others from Fig. 2 for explanation. In Fig. 2, reference numerals 11 and 12 represent a print resistor and a LED drive IC, respectively, and reference numerals 13, 14, and 15 represent a preamplifier IC, a condenser, and a comparator IC, respectively.

The sub-module thus formed is thereafter installed into, for example, a mold for transfer mold, and a cavity of the mold is filled with the mold material 30. As a result of this process, a region shown as a shaded portion in Fig. 3 is sealed with resin. Note that even though the mold material 30 is poured therein, the structure hardly receives the stress when the resin is poured because the conductive wire 4 is a line.

In this way, the optical module is sealed by the mold material 30, so that as shown in Fig. 4, the optical module is integrated (see Fig. 6). Thereafter, the unnecessary parts of the lead frame 3 are cut off, and the outer leads of the lead pins 3d are bent, whereby the optical module as shown in Fig. 5 is completed.

Further, another configuration of the optical module is shown in Fig. 7 and Fig. 8. This optical module differs from the optical module shown in Fig. 1 at the point that the module is for a small-scale link and that a hybrid IC represented by a reference numeral 25 comprises the hybrid ICs 23,24 on the same substrate,

but the rest of the structure is the same as the one shown in Fig. 1, and the same components are represented by the same reference numerals.

Here, every optical modules thus constructed were used to measure a noise included in signal components. For the measurement, a number of conductive wires 4 which are provided at the connection region between the optical connector and the semiconductor chip was changed. For example, Fig. 9 and Fig. 11 show the condition that one conductive wire 4 was provided at each of the transmitter side and the receiver side, and Fig. 10 and Fig. 12 show the condition that two conductive wires 4 were provided at each of the transmitter side and the receiver side. Note that for the measurement, a noise level (crosstalk) for the receiver side was measured by inputting a test signal to the optical connector R and comparing receiving sensitivities of the optical connector R in case of providing the optical connector T with the ECL(Emitter Coupled Logic) signal and without the ECL signal.

The measurement result is shown in Fig. 13. "3-1" and others on a horizontal axis of the graph shown in Fig. 13 are that a number on left hand represents the number of the conductive wires 4 provided at the receiver side, and that a number on right hand represents the number of the conductive wires 4 provided at the transmitter side. In Fig. 13, "sample 1" and "sample 2" represent the different optical modules, and the same measurement was performed for every modules, and each result is shown.

In result, it was studied that even in the case that the one conductive wire 4 was provided at the connection region of the receiver side which was a main noise source, the noise level was reduced. It was also studied that as the number of the conductive wires 4 increased, the noise level tended to decrease. For example, when the three conductive wires 4 are provided at the receiver side and one is provided at the transmitter side, the noise level is reduced to about 1.5 dB.

Further, as another installation form of the conductive wire 4, the conductive wire 4 is possible to be a mesh shape by installing a large number of the conductive wires 4 as shown in Fig. 14 and Fig. 15. In this case, as described above, the ground pattern S is also used to install. The conductive wires 4 are installed in such a form, so that the electromagnetic shielding effect and the ground strengthen.

In each of the embodiments as described above, the conductive wires 4 are provided at the connection regions both between the optical connector R and the semiconductor chip 23, and between the optical connector T and the semiconductor chip 24, but it is also possible that the conductive wire 4 is provided at either one of them.

Further, for the ICs mounted on the hybrid IC 23 and 24, it is possible that the conductive wires 4 are provided and the electrical shielding is applied to strengthen the GND. In this case, for example, as shown in Fig. 17, the structure that the conductive wires 4 are across the comparator IC 15 is preferred. At this time, the both ends of the conductive wire 4 may be connected to the ground pattern S formed on the mounting surface of each of the hybrid IC 23 and 24.

As described above, the optical module is illustrated as comprising the both receiving and transmitting functions, but it is of course possible that the conductive wire 4 as described above is provided at the optical module comprising one of the two functions.

Second Embodiment

The most suitable location of the conductive wire 4 was studied in order to provide an optical module which reduces the effect of noise caused by an atmospheric propagation for electric wave (mainly crosstalk from transmitter side) or the GND/power lines and which provides the good productivity.

For an optical module shown in Fig. 18, the location of the conductive wire 4 was varied, and a noise included in the signal components was measured. In this case, in the same way as the first embodiment, a noise level (crosstalk) for the receiver side was measured by inputting a test signal to the optical connector R and comparing receiving sensitivities of the optical connector R in case of providing the optical connector T with the ECL(Emitter Coupled Logic) signal and without the ECL signal.

Note that Fig. 18 schematically shows the main parts of the optical module which was used in the measurement. In Fig. 18, the same components as the optical module shown in Fig. 2 are represented by the same reference numerals. The wire 2 is omitted in Fig. 18, and the reference numeral 16 represents a through- hole penetrating in a direction of the hybrid IC 23 thickness.

For the measurement, the location of the conductive wire 4 was varied as samples 1 and 3-10 shown in Fig. 19A to Fig. 19I. Note that the conductive wire 4 was not provided in the sample 1 shown in Fig. 19A. Further, as one example, Fig. 20 shows the enlarged region where the conductive wire 4 is placed in the sample 5.

The measurement result is shown in Table 1.

From the result, it is understand that the sample 1, in which the conductive wire 4 is not provided, has the worst sensitivity and has the large amount of degradation due to crosstalk.

The reasons for the worst reception sensitivity are considered hereunder. In the optical connector R side of the samples 3-9, each of the conductive wire is provided in the vertical direction of Figs. 19B to 19I respectively, to connect the connection part 3e with the ground pattern S (as one example, the conductive wire is represented by a reference numeral 4' in Fig. 19B), and further, in the sample 10, the conductive wire is provided in a direction of crossing the connection part between the optical connector R and the hybrid IC 23 (the conductive wire is represented by a reference numeral 4'' in Fig. 19I). It is considered that the conductive wire, which has low impedance, provided in this part serves to strengthen the GND nearby the preamplifier IC 13. Consequently, it seems that the sample 1 which has no conductive wires in this part tends to oscillate, which makes the reception sensitivity worse. It is considered that for the sample 1, the amount of degradation due to crosstalk is very large because no conductive wire 4 is provided thereto.

Next, as described above, for the sample 3-10, oscillation does not occur in the circuit, and based on this assumption, the effects of the conductive wire 4 against the crosstalk are considered.

In comparison of the samples 8 and 9, the following matter can be studied. When the electromagnetic shield is not sufficient, i.e., when the conductive wire 4 is provided not to surround the circumference of the connection part between the optical connector R and the hybrid IC 23 in loop or not to cross this connecting part, to provide the conductive wire 4 to surround the connection part (noise source) of the optical connector T side in loop is more effective in crosstalk. According to the measured data for other samples, when the electromagnetic shield for the optical connector R side is sufficient, the condition of the arrangement of the conductive wires 4 on the optical connector T side has less effect in decrease of the crosstalk.

From the above studies, regarding the characteristics of the optical module, the location of the conductive wire 4 is preferable in the following order of (1), (2), and (3).

(1) To strengthen the GND, the connection part 3e of the lead frame 3 and the ground patterns S on the hybrid IC are connected by the conductive wire 4.

(2) The conductive wire 4 is provided to surround the connection part between the optical connector R side and the hybrid IC, or to cross the connection part.

(3) The conductive wire 4 is provided to surround the connection part between the optical connector T and the semiconductor chip.

In the above-described first and second embodiments, the conductive wire 4 is illustrated as a 150 μm diameter Al bonding wire, but it is not limited to this member, for example, as shown in Fig. 21, a flat ribbon-shaped wire 40 which is called ribbon-bond or equivalents may be used.

Table I Reception sensitivity and the amount of degradation due to crosstalk

Sample No.	Reception sensitivity (TxOff)	Reception sensitivity (TxOn)	The amount of degradation due to crosstalk
1	-31.80	-24.75	7.05
3	-36.40	-35.00	1.40
4	-36.70	-35.65	1.05
5	-36.95	-35.75	1.20
6	-36.65	-35.75	0.90
7	-36.65	-35.65	1.00
8	-37.00	-35.60	1.40
9	-36.80	-34.70	2.10
10	-36.10	-34.95	1.15
Unit	dBm	dBm	dB

Claims

1. An optical module sealed by mold material comprising:

an optical connector (R) comprising a light receiving device (21) for converting an optical signal into an electric signal;

a first substrate (23) comprising a circuit which is electrically connected to an output terminal of said light receiving device (21) through a signal connecting wire (2), for processing an electric signal coming from the output terminal;

a mounting substrate (3a) for mounting said first substrate (23); and

a conductive wire (4; 40) placed nearby a connection part between said optical connector (R) and

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said first substrate (23) without contacting said signal connecting wire (2);

said mounting substrate (3a) comprising a first reference potential region (3e) being of a part of the mounting substrate (3a) and projecting outside from a part where said first substrate (23) is mounted;

said first substrate (23) comprising a second reference potential region (S) on a surface of the first substrate (23), which region is electrically connected to said mounting substrate (3a);

one end of said conductive wire (4; 40) being connected to one of said first reference potential region (3e) and said second reference potential region (S), and the other end of said conductive wire (4; 40) being connected to one of said first reference potential region (3e) and said second reference potential region (S).

2. An optical module sealed by mold material comprising:

a first optical connector (R) comprising a light receiving device (21) for converting an optical signal into an electric signal;

a first substrate (23) comprising a circuit which is electrically connected to an output terminal of said light receiving device (21) through a first signal connecting wire (2), for processing an electric signal coming from the output terminal;

a first mounting substrate (3a) for mounting said first substrate (23);

a second optical connector (T) comprising a light emitting device (22) for converting an electric signal into an optical signal;

a second substrate (24) comprising a circuit which is electrically connected to an input terminal of said light emitting device (22) through a second signal connecting wire (2), for applying an electric signal to the input terminal;

a second mounting substrate (3a) for mounting said second substrate (24), electrically connected to said first mounting substrate (3a); and

a conductive wire (4; 40) placed nearby a connection part between said first optical connector (R) and said first substrate (23) without contacting said first signal connecting wire (2);

said first mounting substrate (3a) comprising a first reference potential region (3e) being of a part of the first mounting substrate (3a) and projecting outside from a part where said first substrate (23) is mounted;

said first substrate (23) comprising a second reference potential region (S) on a surface of said first substrate (23), which region is electrically connected to said first mounting substrate (3a);

one end of said conductive wire (4; 40) being connected to one of said first reference potential region (3e) and said second reference potential region (S), and the other end of said conductive wire (4; 40) being connected to one of said first reference potential region (3e) and said second reference potential region (S).

3. An optical module according to claim 1 or 2, wherein said conductive wire (4; 40) is placed at one side bordering said (first) signal connecting wire (2), and one end of the conductive wire (4; 40) is connected to said first reference potential region (3e), and the other end of the conductive wire (4; 40) is connected to said second reference potential region (S).

4. An optical module according to claim 3, wherein said first substrate (23) comprises an amplifier (13) for amplifying an output signal of said light receiving device (21); and

one end of said conductive wire (4; 40) is connected to said second reference potential region (S) nearby the part where the amplifier (13) is placed.

5. An optical module according to claim 1 or 2, wherein said conductive wire (4; 40) is placed, crossing with said (first) signal connecting wire (2), and one end of said conductive wire (4; 40) is connected to said first reference potential region (3e) and the other end of said conductive wire (4; 40) is connected to said second reference potential region (S).

6. An optical module according to claim 1 or 2, wherein said conductive wire (4; 40) is placed at a plurality of places so that a region where said (first) signal connecting wire (2) is placed is surrounded.

7. An optical module according to any of claims 1 to 6, wherein said conductive wire is a bonding wire (4) or a flat ribbon-shaped wire (40).

8. An optical module according to any of claims 1 to 7, wherein said mounting substrate(s) (3a; 3a) is (are) a part of a lead frame (3).

9. An optical module according to any of claims 1 to 8, wherein the potential applied to said first and second reference potential regions (3e, S) is a ground potential.

10. An optical module sealed by mold material comprising:

a first optical connector (R) comprising a light receiving device (21) for converting an optical signal into an electric signal;

a first substrate (23) comprising a circuit which is electrically connected to an output terminal of said light receiving device (21) through a first signal connecting wire (2), for processing an electric signal coming from the output terminal;

a first mounting substrate (3a) for mounting said first substrate (23);

a second optical connector (T) comprising a light emitting device (22) for converting an electric signal into an optical signal;

a second substrate (24) comprising a circuit which is electrically connected to an input terminal of said light emitting device (22) through a second signal connecting wire (2), for applying an electric signal to the input terminal;

a second mounting substrate (3a) for mounting said second substrate (24), electrically connected to said first mounting substrate (3a);

a first conductive wire (4; 40) placed nearby a connection part between said first optical connector (R) and said first substrate (23) without contacting said first signal connecting wire (2); and

a second conductive wire (4; 40) placed nearby a connection part between said second optical connector (T) and said second substrate (24) without contacting said second signal connecting wire (2);

said first mounting substrate (3a) comprising a first reference potential region (3e) being of a part of the first mounting substrate (3a) and projecting outside from a part where said first substrate (23) is mounted;

said first substrate (23) comprising a second reference potential region (S) on a surface of said first substrate (23), which region is electrically connected to said first mounting substrate (3a);

one end of said first conductive wire (4; 40) being connected to one of said first reference potential region (3e) and said second reference potential region (S), and the other end of said first conductive wire (4; 40) being connected to one of said first reference potential region (3e) and said second reference potential region (S);

said second mounting substrate (3a) comprising a third reference potential region (3e) being of a part of the second mounting substrate (3a) and projecting outside from a part where said second substrate (24) is mounted;

said second substrate (24) comprising a fourth reference potential region (S) on a surface of said second substrate (24), which region is electrically connected to said second mounting substrate (3a); and

one end of said second conductive wire (4; 40) being connected to one of said third reference potential region (3e) and said fourth reference potential region (S), and the other end of said second conductive wire (4; 40) being connected to one of said third reference potential region (3e) and said fourth reference potential region (S).

11. An optical module according to claim 10, wherein said first conductive wire (4; 40) is placed at a plurality of places so that a region where said first signal connecting wire (2) is placed is surrounded; and

said second conductive wire (4; 40) is placed at both sides bordering said second signal connecting wire (2), and one end of each said second conductive wire (4; 40) is connected to said third reference potential region (3e), and the other end of each said second conductive wire (4; 40) is connected to said fourth reference potential region (S).

12. An optical module according to claim 10 or 11, wherein said first conductive wire is a bonding wire (4) or a flat ribbon-shaped wire (40).

13. An optical module according to any of claims 10 to 12,
wherein said second conductive wire is a bonding wire (4) or a flat ribbon-shaped wire (40).

14. An optical module according to any of claims 10 to 13,
   wherein said first and second mounting substrates (3a, 3a) are a part of a lead frame (3).

15. An optical module according to any of claims 10 to 14,
   wherein the potential applied to said first to fourth reference potential regions is a ground potential.
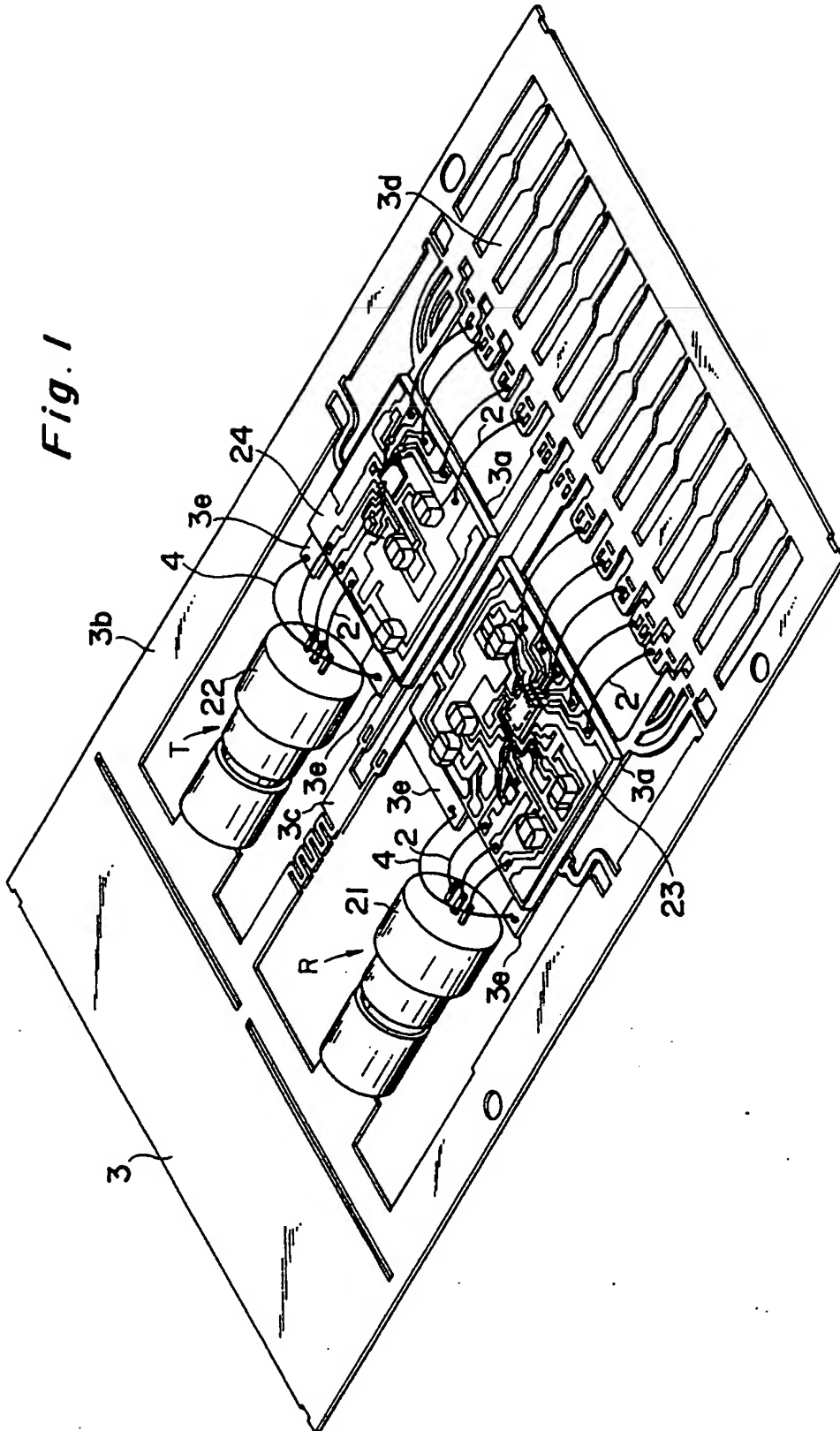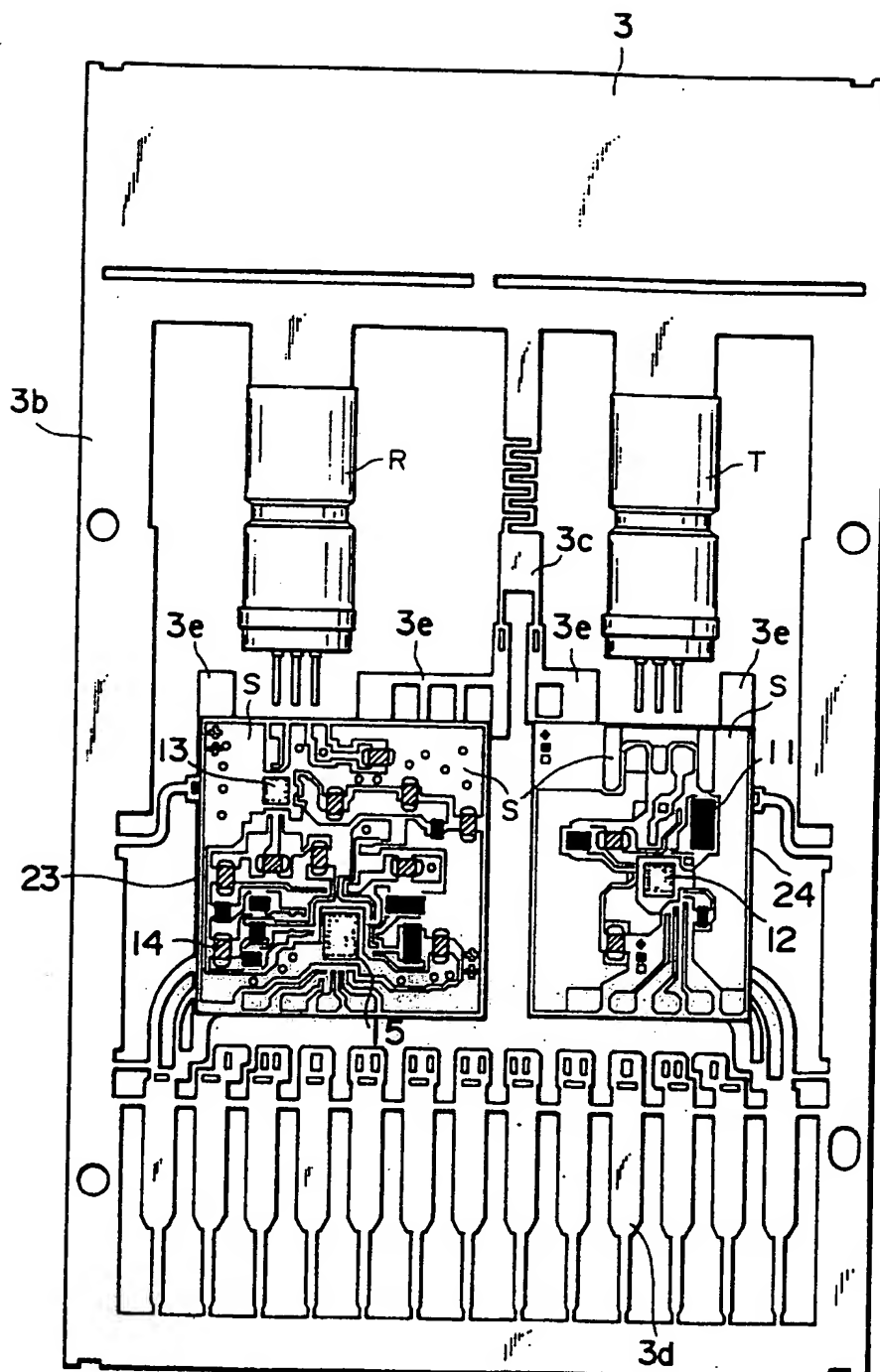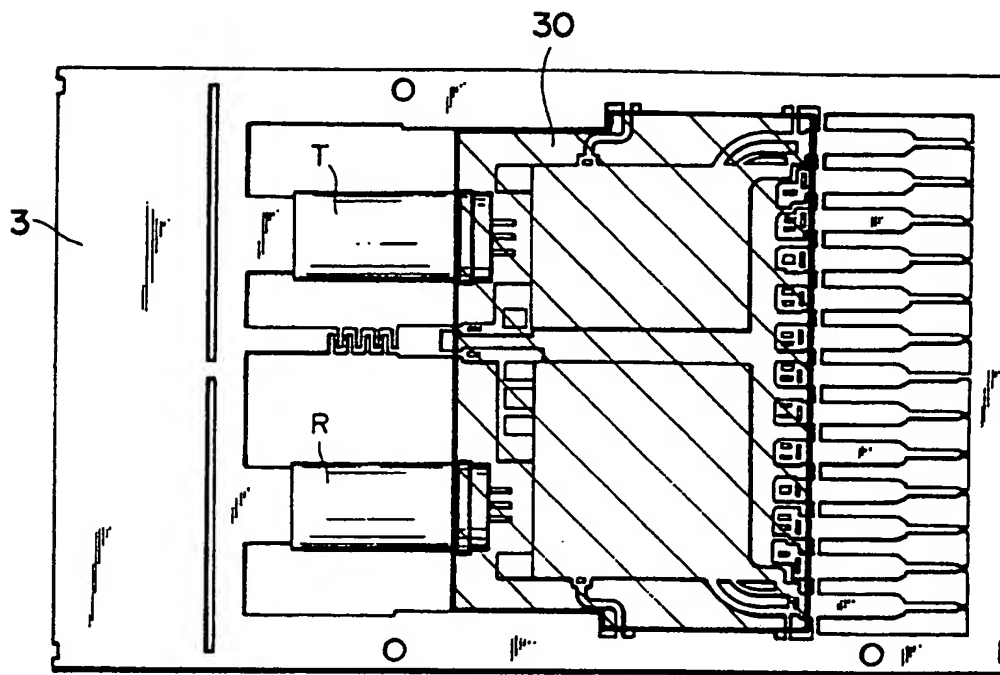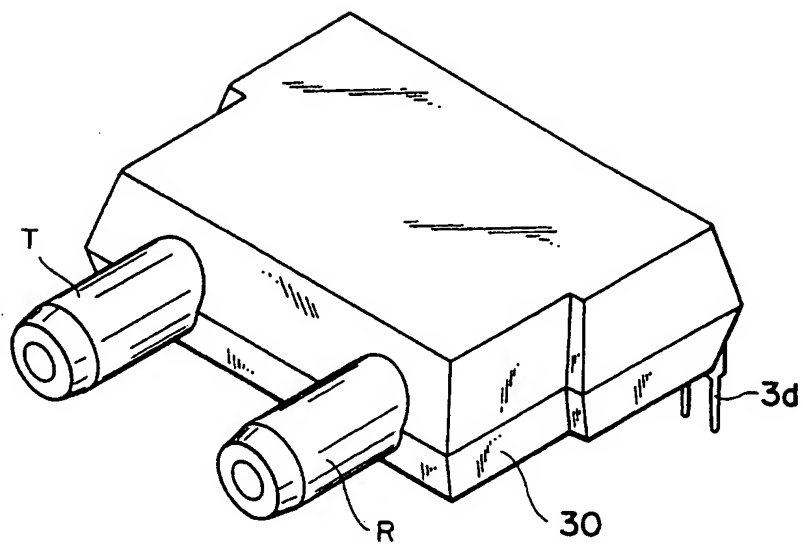
Fig. 1

Fig.2

Fig. 3

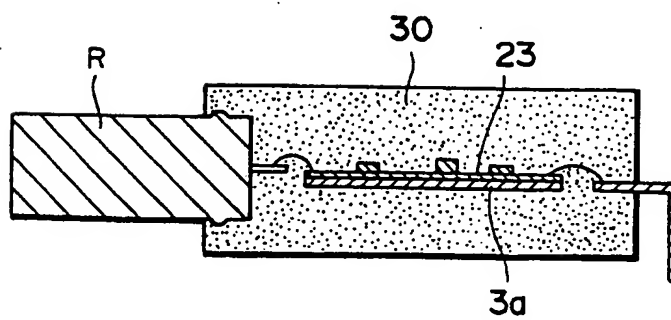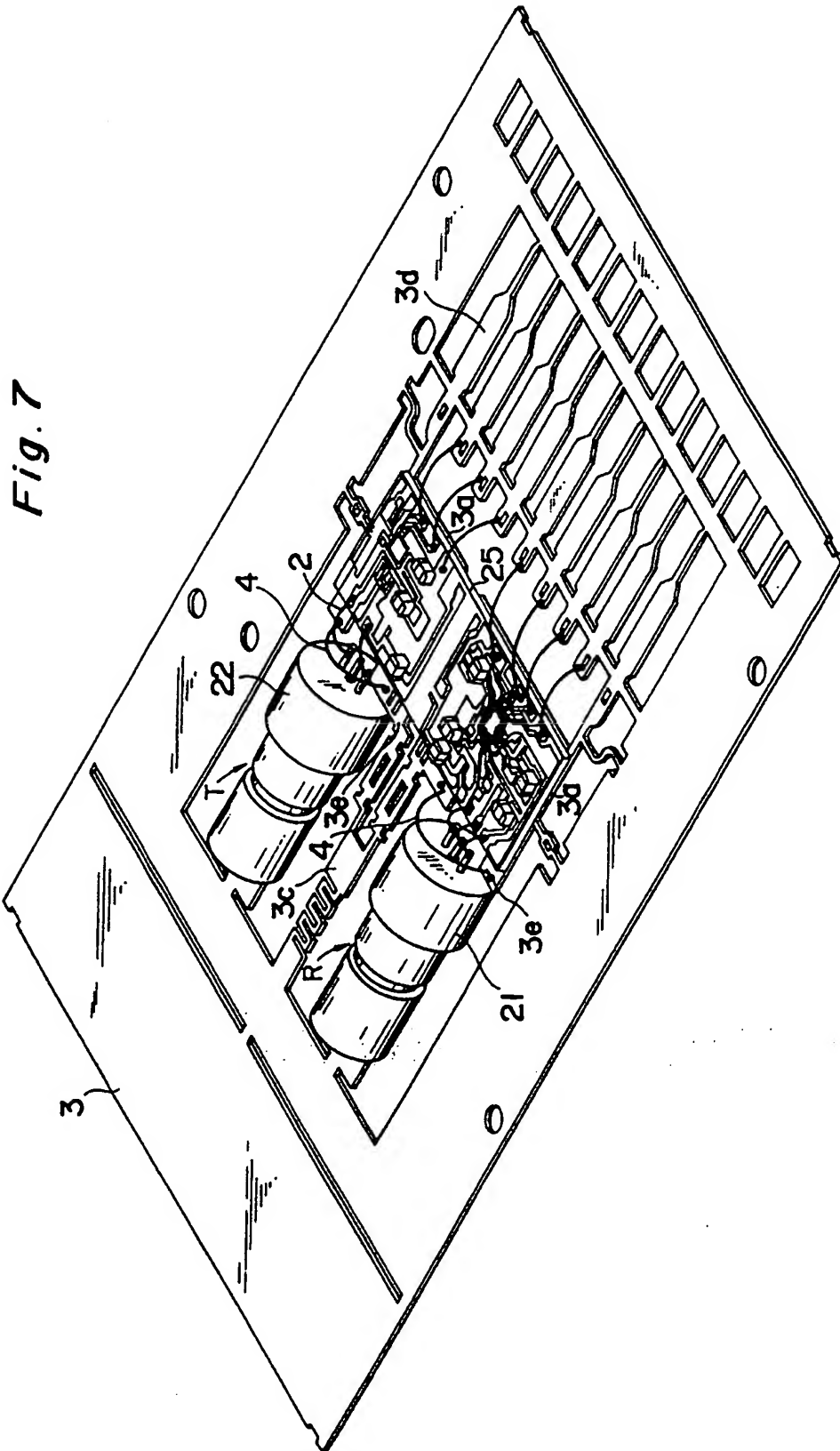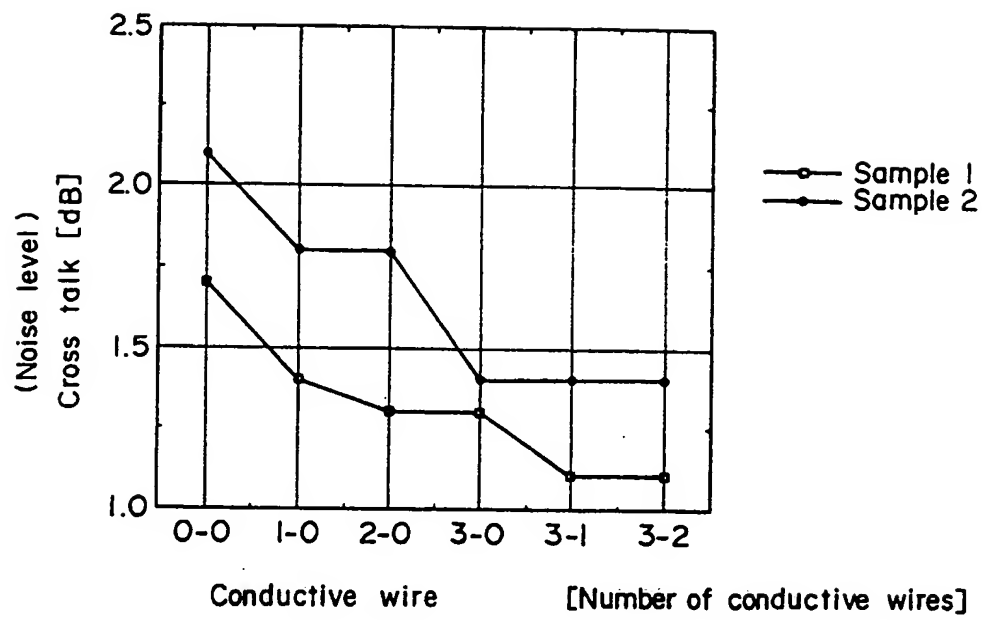# Fig. 4

Fig. 5

Fig. 6

Fig. 7
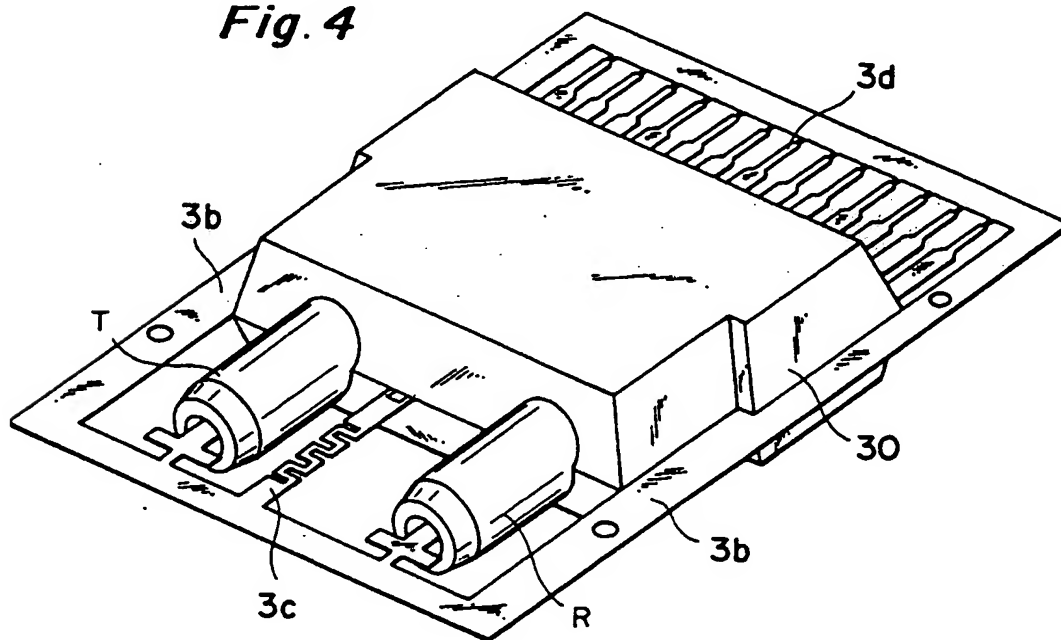
Fig.8
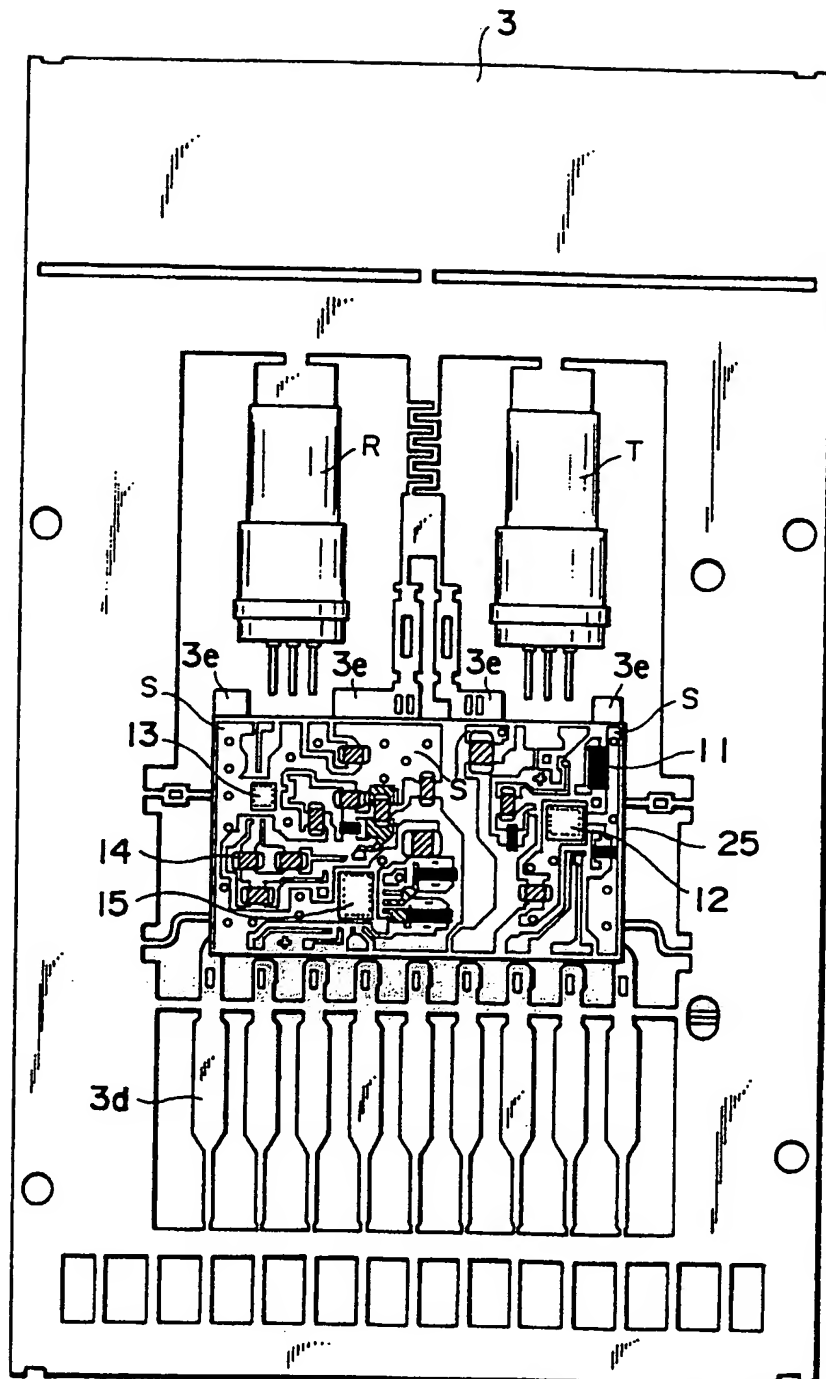
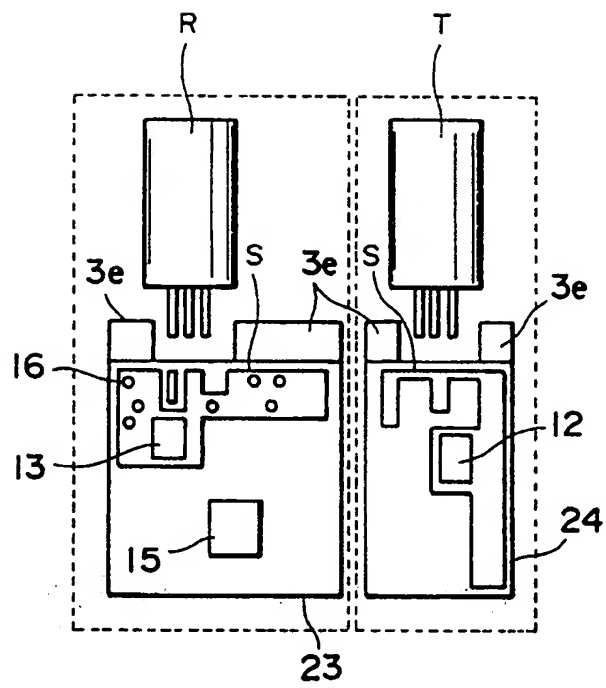# Fig. 9
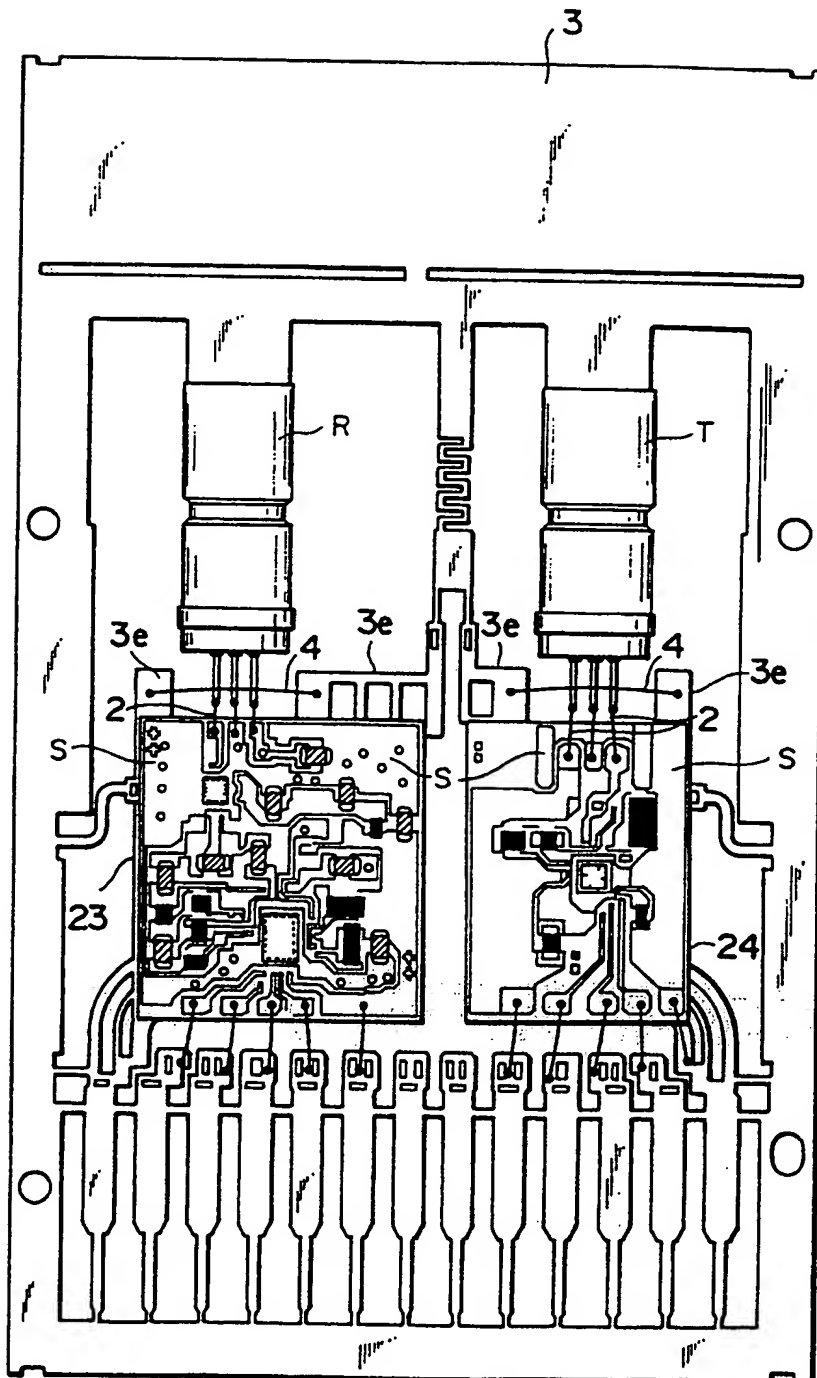
Fig. 10
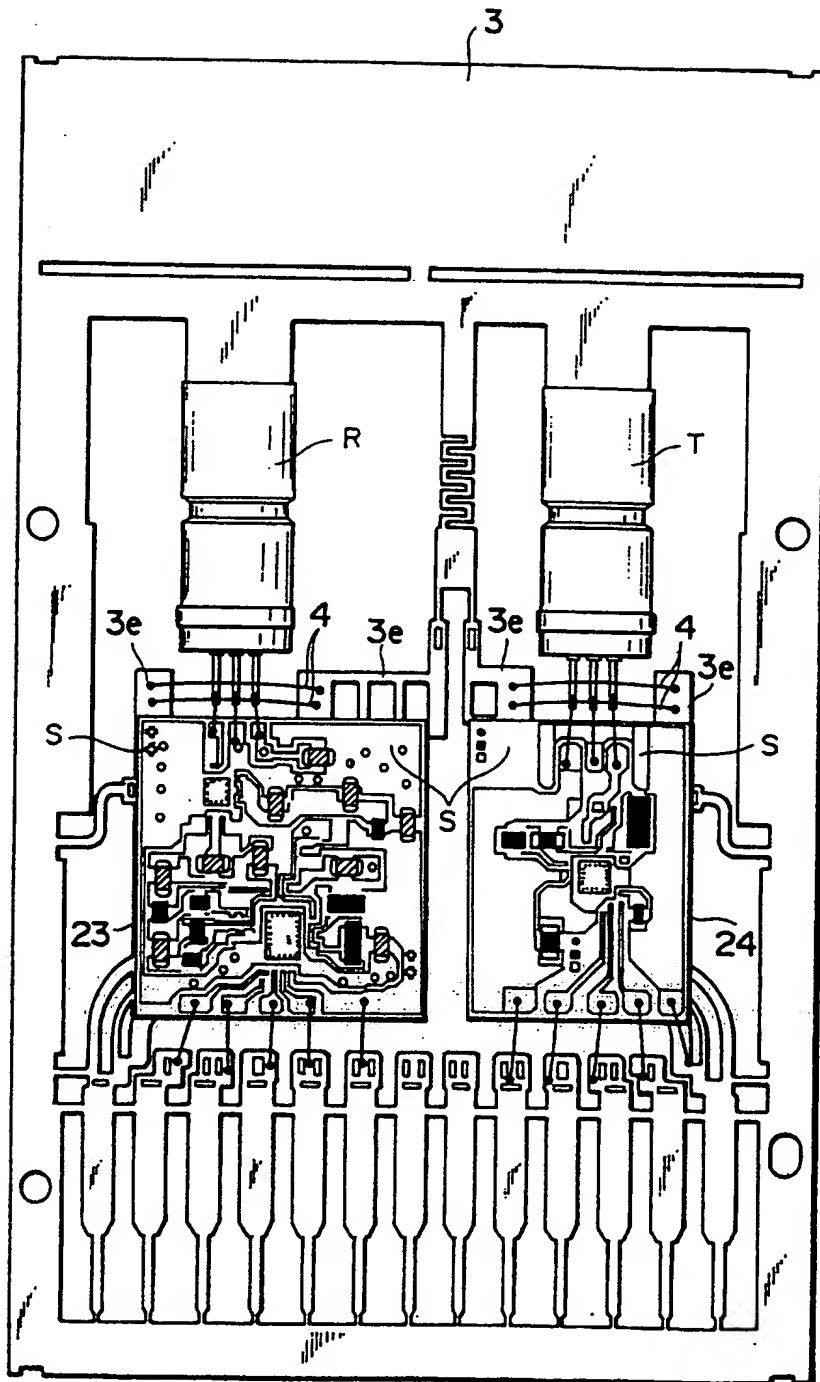
Fig. 11
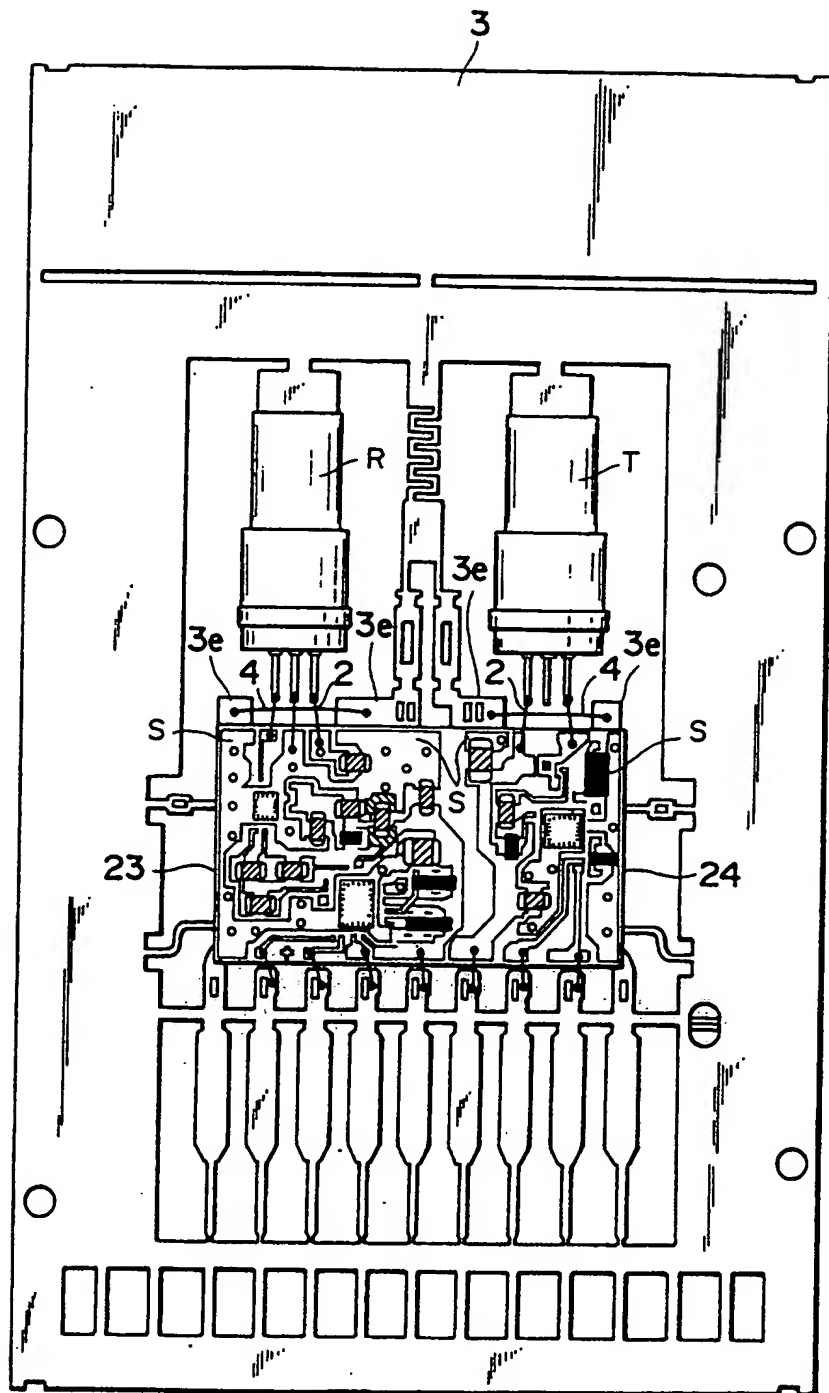
Fig. 12
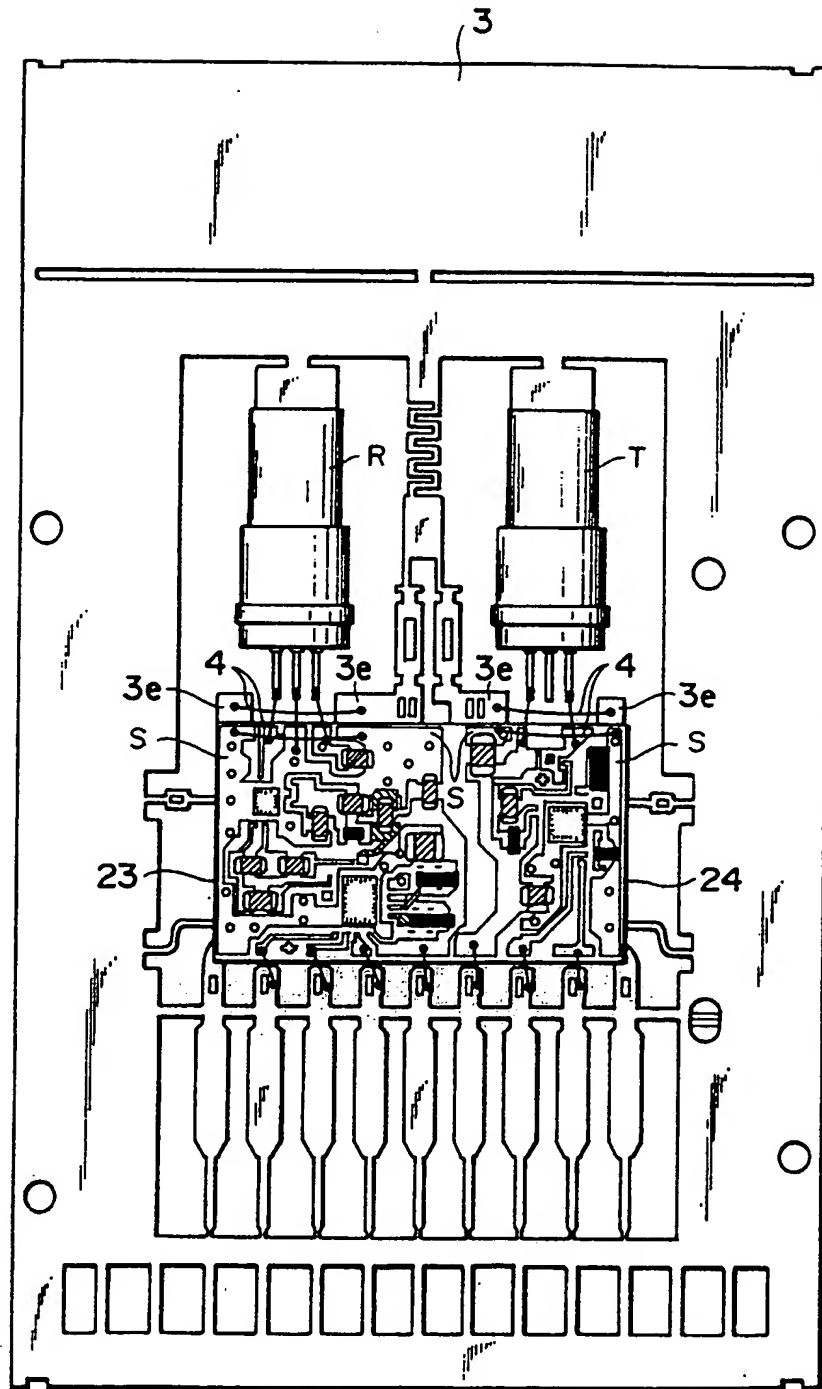
Fig. 13

Fig. 14
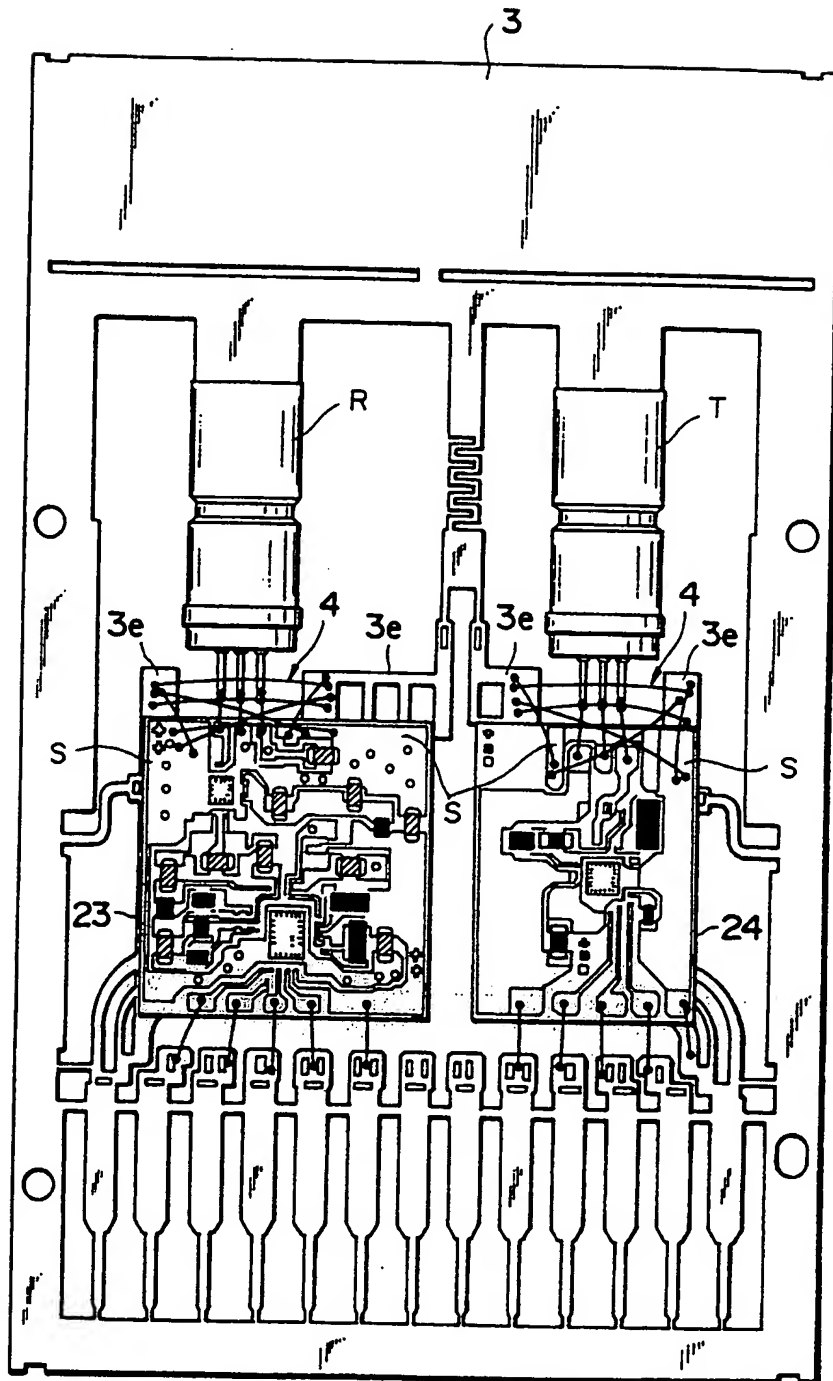
Fig. 15
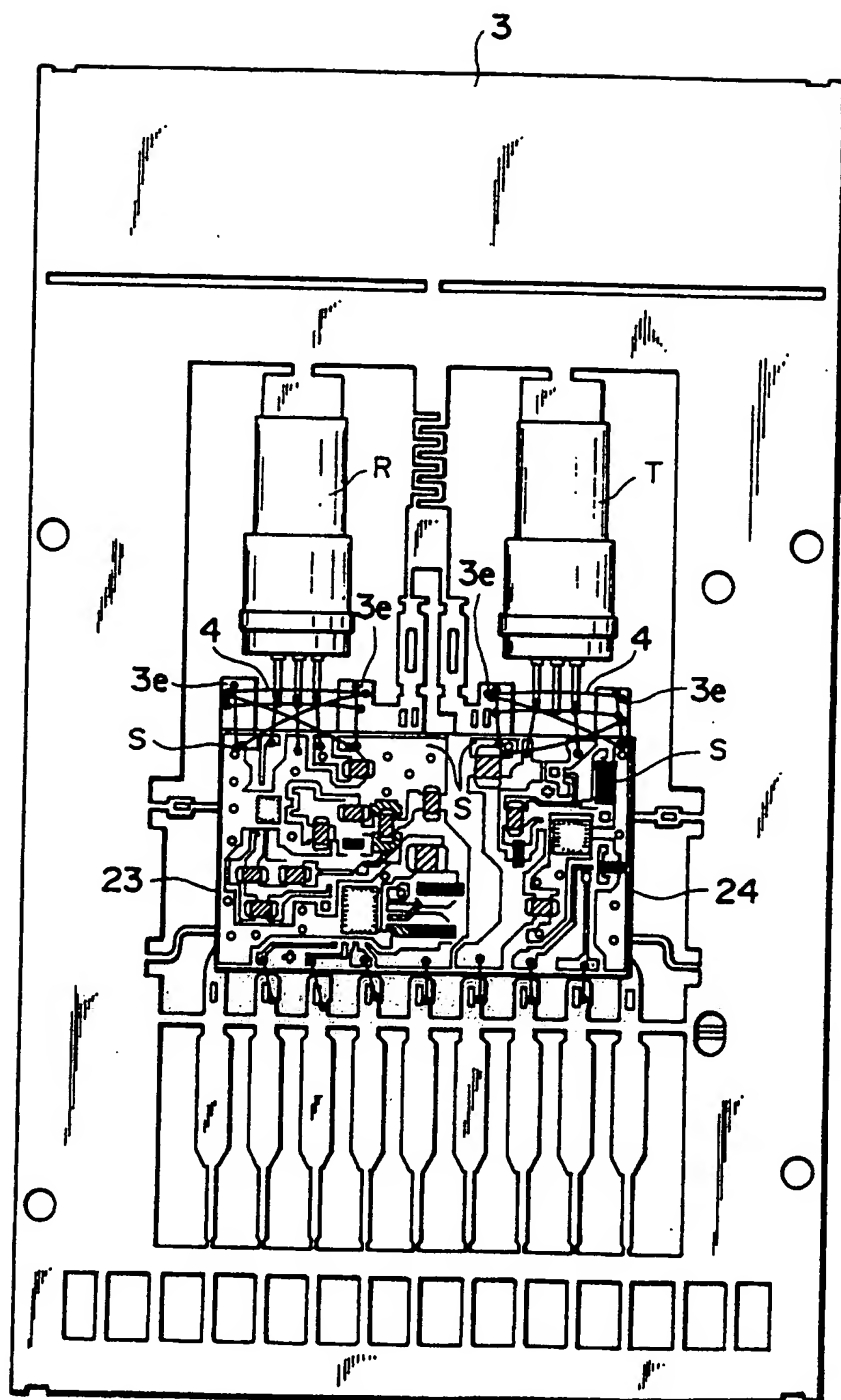
Fig.16
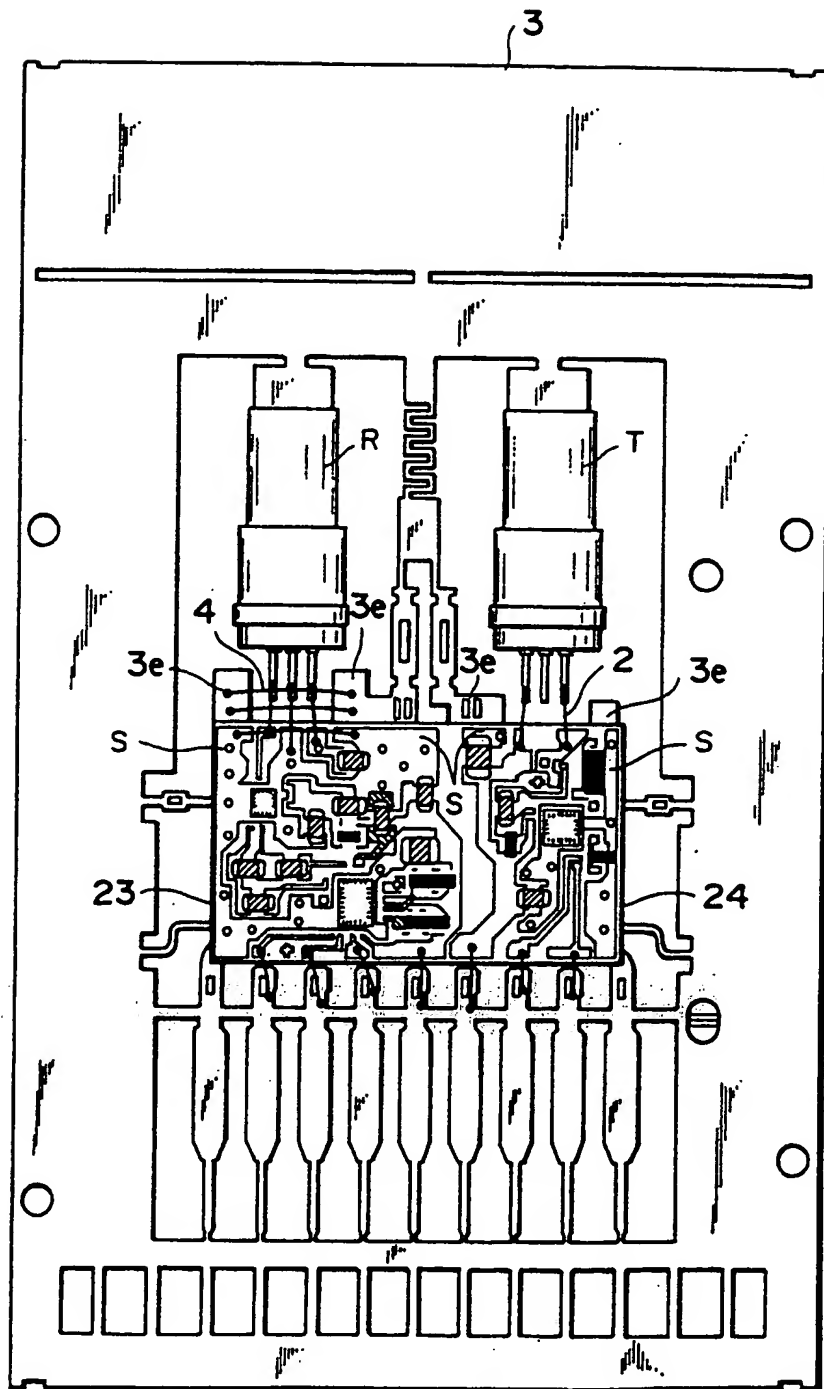
Fig.17
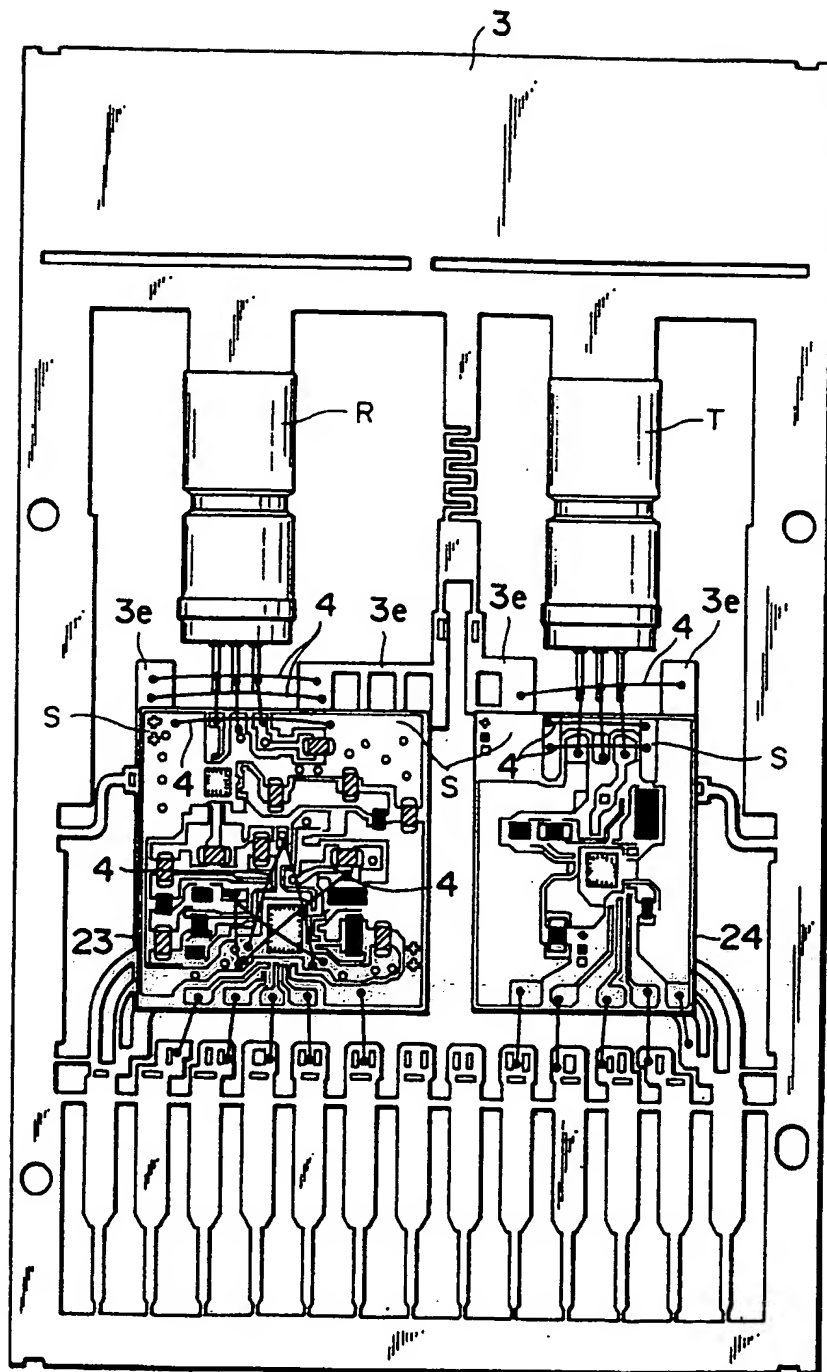
Fig.18

Fig.19A
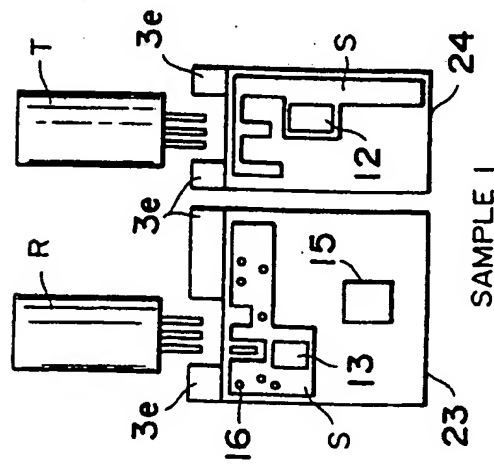
Fig.19B
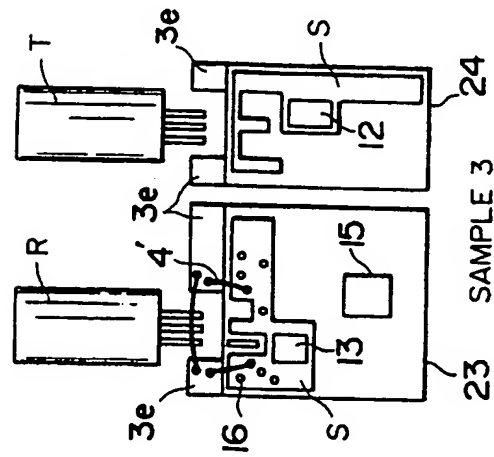
Fig.19C
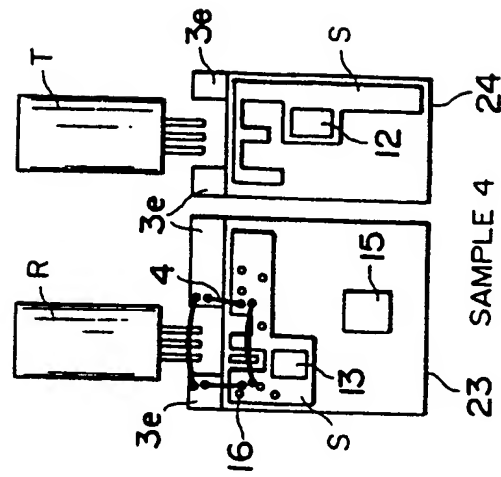
Fig.19D   Fig.19E   Fig.19F

SAMPLE 5   SAMPLE 6   SAMPLE 7
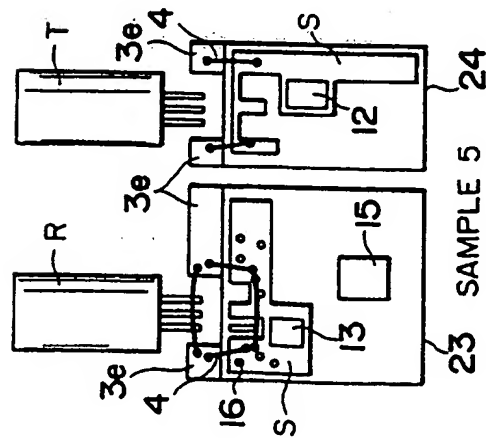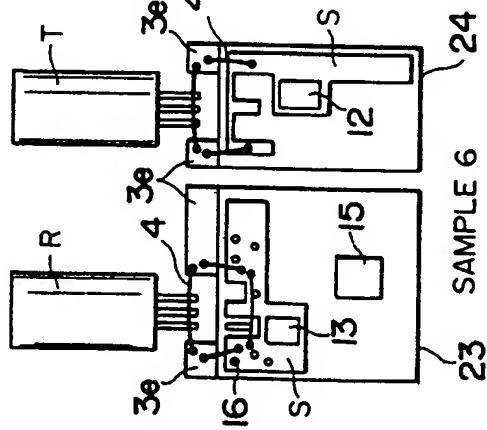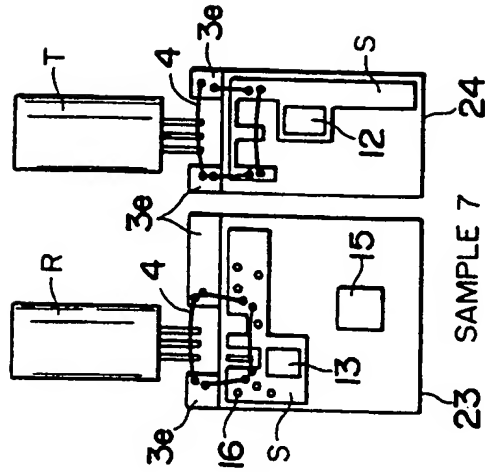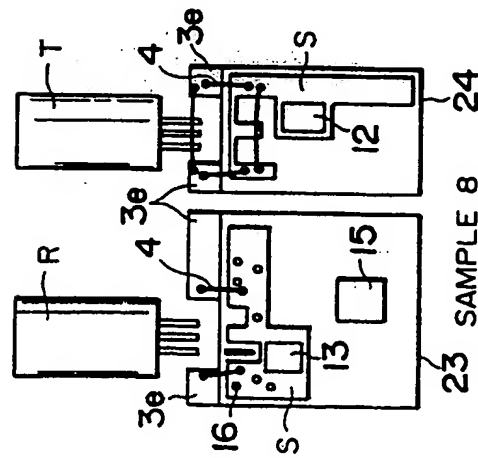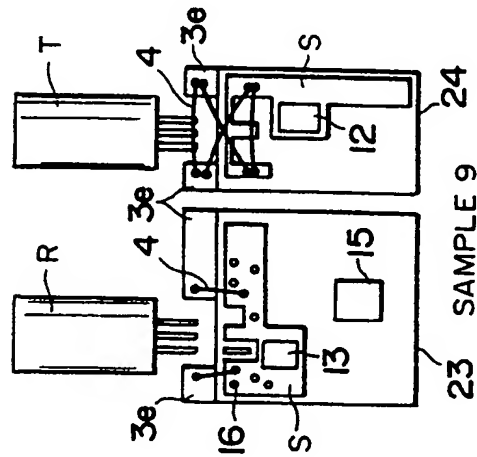
Fig.19G

Fig.19H

Fig.19I
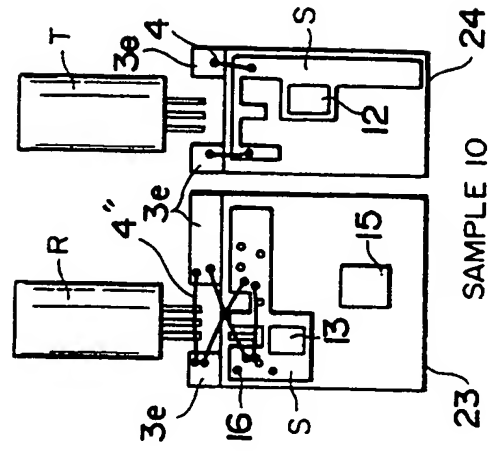
Fig.20
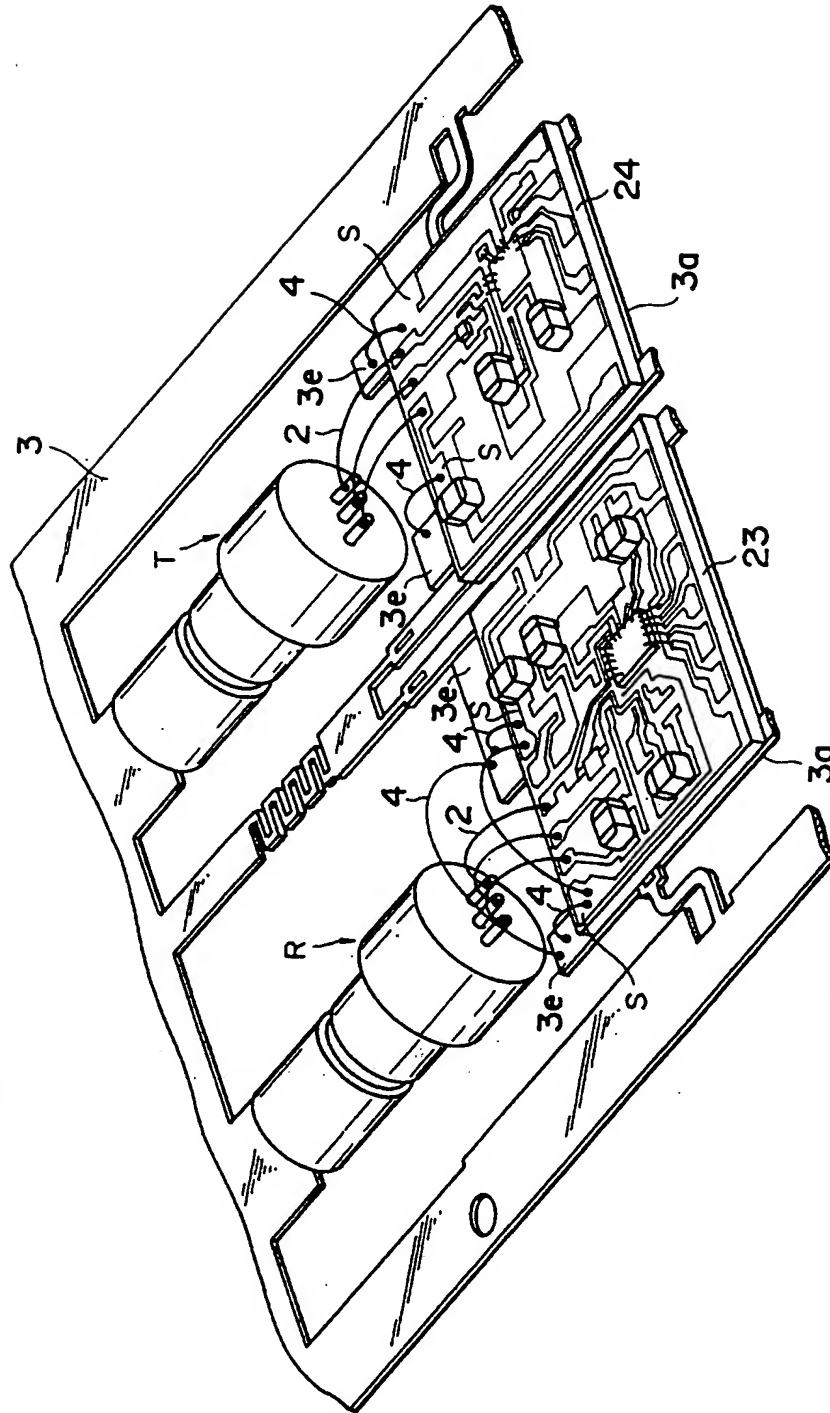
Fig.21
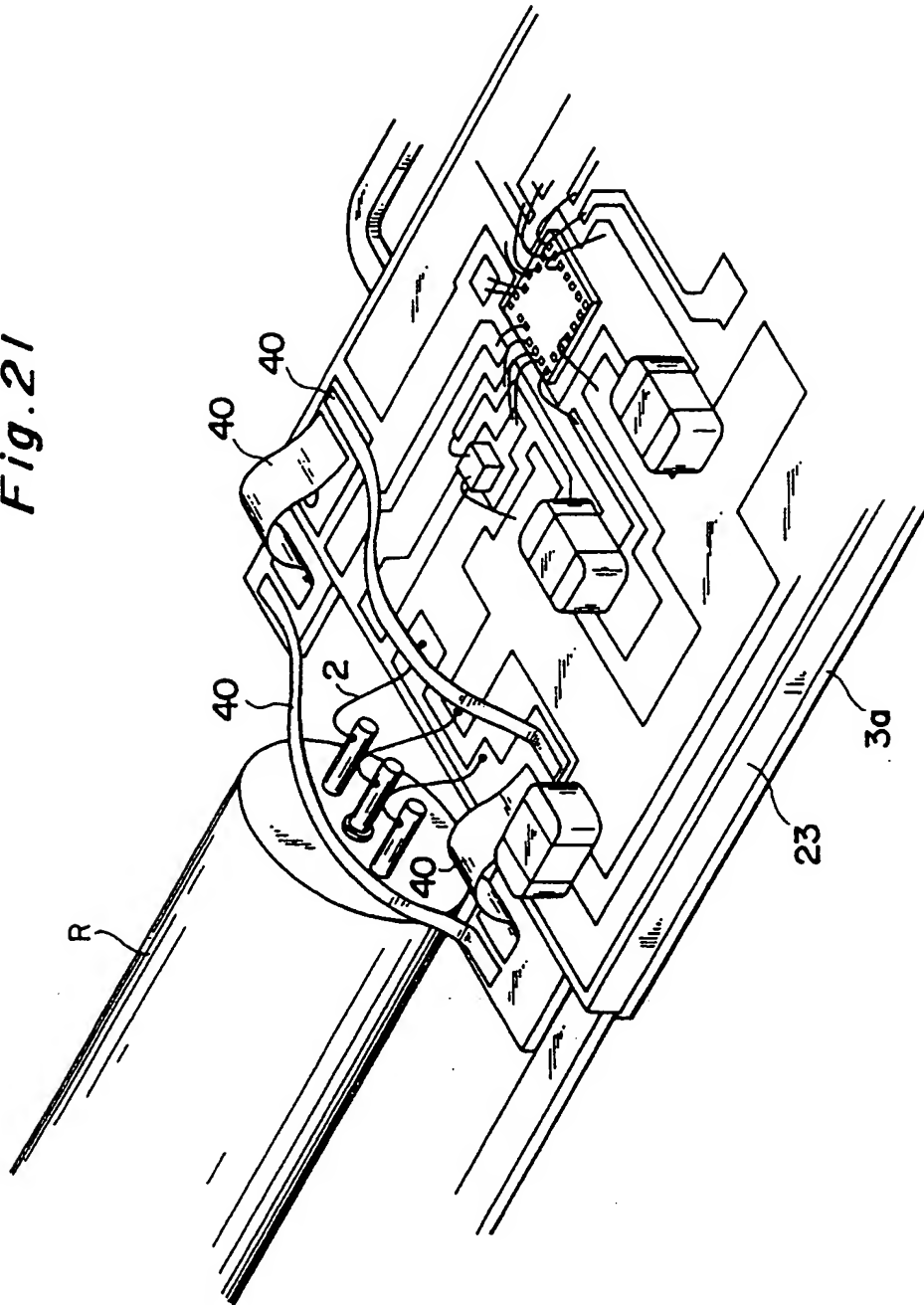
Human-machine interface for a control system

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority to U.S. provisional patent
application 60/667,080 filed 1 April 2005.

TECHNICAL FIELD.

The present invention concerns a human machine interface for a
system for control and/or monitoring of an industrial process,
automated equipment or a device. The invention may be applied
in many fields such as oil and gas, electricity generation,
transmission, distribution as well as in industry. The
invention may be applied to monitoring, control and/or
programming of an industrial robot for robotic and automated
applications.

BACKGROUND ART

A technician or a field operator, e.g. in a process plant,
manufacturing installation, at off-shore oil and gas platform
or at an electrical power transmission or distribution
installation or substation, needs to check on alarms and other
events reported by a control system, as well as interact with
systems or devices in the installed equipment on a daily
basis. An operator also has to have access to information and
documentation about the process(es) and the installed
equipment. However various user interfaces, both physical and
software interfaces, for the installed equipment, operating
devices and for one or more supervisory control systems and so
on are often designed differently so that the field operators
have to learn how to use a multitude of different user
interfaces. The different equipment interfaces may also often
be inconsistent with respect to each other.

US 5,032,978 to Westinghouse, entitled Status tree monitoring

and display system describes a display, a display method and an apparatus are disclosed which produce a summary display depicting function states using discrete state bars centered in one window of a two-window display. The display is

5   presented to solve a problem that in many complex processes, the operator is confronted with a vast amount of information that must be analyzed before appropriate action can be taken.

The field operator, as well as interacting with installed

10   equipment or devices or systems, needs access to documentation of some kind, which may be a manual, historical data, maintenance history & repair reports and the like. Even though the trend is that parts of such documentation has become electronically available, it is often stored in different

15   systems and at different locations. Therefore, the field operators either have to plan information gathering for their work tasks in advance, or they have to interrupt ongoing tasks in order to find and then access support information and documentation for the installed equipment, process or device.

20   In addition, the process of obtaining information about an alarm or about a device may take considerable time, and may require that an operator browses through many databases. A considerable amount of time may be necessary to search by name or system identification for information about a device or

25   process. In critical or emergency situations, it is very important to obtain relevant technical information quickly to avoid material damage to plant to process as well as possible injury to persons in the plant.

30   SUMMARY OF THE INVENTION
A primary aim of the present invention is to provide human-machine interface of a control system for monitoring and control of a process, comprising a computer generated model of the process displaying said process or a part or component of

said process wherein in that said model is a 2-D or 3-D model which is arranged to map from a point on the computer generated model to data held by said control system about the selected at least one part or component of said process.

5   control an industrial automation process.

A secondary aim of the present invention is to provide graphic information manipulate-able by an operator to retrieve, examine and use in direct relation to a specific equipment

10   and/or device or equipment, plant or process by means of selecting and/or activating a point on a 2-D or 3-D model of the process, which point is mappable via setpoints watchpoints or other data points to execute an instruction to retrieve technical information. Another aim is to provide additional

15   information in the form of graphic information manipulate-able by an operator to access, examine and/or carry out control actions for a specific equipment, plant, device or process.

The above and more aims are achieved according to the

20   invention by a human machine interface and a system according to embodiments of the present invention.

According to a first aspect of the invention, a human machine interface of a control system for monitoring and control of a

25   process or equipment, comprising a computer generated model of the process displayed, is described. Information, data and/or instructions for the process or a part or component of said process are provided by manipulating the HMI 2-D or 3-D model. Spicial points, setpoints or watchpoints in the model are

30   mapped to the control system. The operator activates or selects a device and can reteireve technical information, send an instruction, monitor or configure that device via the interface provided by the 3-D or 3-D graphic model.

According to a second aspect of the invention, a human machine interface of a control system for monitoring and control of a process, comprising a computer generated model of the process displaying said process or a part or component of said process

5   is described for displaying the control system information to one or more remotely located experts for further interaction via the HMI, and for further interaction with an original user or operator.

10   According to a third aspect of the invention, a human machine interface of a control system for monitoring and control of a process, comprising a computer generated model of the process displaying said process or a part or component of said process which generated display information the operator may use to

15   guide him/her through the plant or process to a specific location of the specific equipment by means of a 2-D model of the plant or layout, and/or by means of a 3-D model.

The general aim of this invention is to provide a fast and

20   efficient way to locate specific process or equipment control data held by a control system. The user points to the valve or mixer or press on the model and is routed to the control system information held for that part or device. Online real time data, setpoints, configuration data, service history, any

25   information associated with that device by the control system may be intuitively found and then retrieved. The information obtained may be displayed to a field operator (e.g. an operator, a service technician, a maintenance person, OEM, a process engineer, etc. or to a remote person, expert, other

30   operator etc. First of all, the HMI and the described methods provide relevant information intuitively and quickly to the field operator for monitoring and interaction with the industrial process or device.

The HMI and system herein is described below in detail with respect to an oil and gas platform. The HMI described may be used to interface with the control system for other processes, or productions processes or automated equipment. Brief
5   examples in the form of scenarios for use of the HMI will now be described.

Service Team performs maintenance on platform

Task: Service team receives assistance and guidance by control
10   room operators

Industry: Oil & Gas

When the control room can visualize both plant and process as a 3D model, both service personnel and control room operators can get detailed, local information about locations, equipment
15   and components. This provides service personnel with improved and more efficient guidance and assistance from control room operators. The exact position of the service team can be viewed by control room operators, and a direct communication link with document sharing, video and sound can be used to
20   transmit information. The control room operators can issue work orders to the service team that is closest to the equipment and the work order can be discussed similar to if they were co-located. The control room personnel can access a 3D model with graphical representations of the service team,
25   real-time process information, historical databases, maintenance records, procedure descriptions or manuals and thereby provide better assistance and guidance to service teams.

30   Design and Planning an upgrade of the plant

Task: Visualize and simulate operation and integration of new system

Industry: Process industry

There are often spatial constraints and compatibility issues

when upgrading or changing process equipment. If the control
room has access to and maintains an updated version of a 3D
model of the process and plant, this can be used for planning
an upgrade and for examining tenders. The 3D model can be

5   examined with and without the suggested upgrade, and
feasibility, compatibility and spatial issues can be discussed
and examined visually. Both overall compatibility and detail-
specific issues can be examined by zooming/abstraction and by
interacting with the virtual model.

10

Process control engineers aid field operators
Task: Improve process performance at component level
Industry: Process industry
Access to a 3D model with advanced interaction possibilities

15   can help process control engineers in communicating with field
operators, control room operators, subcontractors and other
involved parties.

Operators in control room supervise field operators

20   Task: Supervise field operators, assist and issue work orders
when necessary
Industry: Process industry
The presence of field operators and other personnel on the
plant floor is often perceived as a stress factor for control

25   room operators. This is because the control room operators do
not know the exact position and status of these people and
direct communication is not always possible. A 3D model of the
plant with avatars representing the exact position of all
personnel can reduce this stress. Furthermore, advanced

30   information and communication technology can establish
efficient multi-modal communication channels quickly. The 3D
model of the plant can also aid operators in assisting
personnel on the plant floor or when communicating with
external or remote experts. The 3D model can give detailed

information about the immediate surroundings of the field operator that needs assistance, for example by highlighting the electric system, pipelines, valves, pumps or other relevant components.

5

Production managers ensuring high process performance
Task: Identify bottlenecks and inefficiencies in current production system
Industry: Oil & Gas

10 A 3D model of plant and process equipment can aid in understanding deficiencies or sub-optimal performance when examining the current process. By highlighting the equipment directly related to the process at hand, e.g. by making the rest of the 3D model transparent and coding performance levels

15 into different colors, can be used to understand the situation and identify bottlenecks. This is also an efficient method for communicating and discussing solutions between process control engineers, control room and field operators, production managers, and other involved parties.

20

Electrification and a planned maintenance or upgrade of electrical system on a platform
Task: Plan re-routing of electrical system around section to be upgraded

25 Industry: Oil & Gas
Control room operators and service team meet and plan the upcoming maintenance work on the electric system for a section of the plant. The 3D model of the platform displays the electric circuitry with the relevant power generators in a

30 (semi-) transparent view of the platform. The possible re-routings can be displayed and the impact can be examined visually for each possibility and all actors can interact with the model to highlight important areas or features directly. This creates a simple and unambiguous foundation for

discussion and decision-making.

Safety and a periodical safety check of all valves
Task: Control room operators perform safety check of all
5 valves
Industry: Process industry

Emergency teams and a fire on a floor of the plant
Task: Assess situation and plan rescue strategy with emergency
10 team
Industry: Process industry
When a fire occurs on the plant floor, the firefighters,
ambulance and rescue teams need to be informed of information
such as: the exact location of the fire and of any personnel,
15 any dangerous leakages, spills or possible can happen, and how
to access these areas. Such information can be presented most
efficiently by a 3D model of the plant, and/or a 2-D model. A
2-D model that graphically visualises the floor layout for a
given production floor and indicates, with for example
20 flashing arrow signs overlaid on the floor of the layout plan,
the route to the nearest fire exit. Such a model provides
information that may be understood even in the stress of an
emergency situation, without any necessity for the viewer to
understand or even read text. The control room, because of the
25 HMI and because of its access to technical process
information, can also function as a temporary emergency centre
where the emergency teams can get information and also discuss
possible solutions or rescue strategies with operators or
engineers.
30
Authorities make a Safety inspection, eg the Railroad
Inspectorate
Task: Authorities inspect situation at complex multi-track
rail stations

Industry: Railroad

When the proper railroad authorities inspect safety and efficiency considerations of the railroad system, a 3D model and/or 2-D model can be an efficient means for communication
5   and discussion. There are severe restrictions on how trains can change tracks and move about on the track system, and in large station areas the situation can be very complex and difficult to grasp. A 3D model of the tracks and trains can be used to visualize how the trains move between the tracks and
10 to ensure all regulations are followed. Certain laws, conditions and restrictions can also be visualized directly in the model, e.g. how much space or time must pass between two consecutive trains, between two trains on intersecting tracks, and so on. In certain circumstances 2-D models may also be
15 used.

In addition, further and advantageous aspects of the invention are described in relation to a graphical user interface, a computer program for implementing the method and a computer
20 program product including the computer program.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the invention will now be described, by way of example only, with particular reference to the accompanying
25 drawings in which:

FIGURE 1a and 1b are a schematic representations of a display of a human machine interface for monitoring and controlling a process, the example shown being of an oil production platform
30 according to an embodiment of the invention;

FIGURE 2 is a schematic representation of a display of a human machine interface showing a close up and an alarm state according to another embodiment of the invention;

FIGURES 3a, 3b and 3c are schematic representations of a display of a human machine interface, each diagram showing a display of one or more selected layers of information
5   according to a third embodiment of the invention;

FIGURE 4 a schematic representation of a display of a human machine interface showing a display of a group of operational or functional data selectable for a selected one or more
10   component parts of the process according to another embodiment of the invention;

FIGURE 5 is a display of a human machine interface showing a location structure which comprises information about the
15   physical location of a selected one or more component parts of the process;

FIGURE 6 is a display of a human machine interface showing a part of the HMI display being arranged rotatable about an axis
20   according to another embodiment of the invention;

FIGURE 7 is a display of a human machine interface showing operational facets of a device that are liked to data stored in a control about the selected one or more component parts of
25   the process;

FIGURE 8 is a schematic flowchart for a method to handle an alarm using the HMI to control and monitor a process according to an embodiment of the invention;

30

FIGURE 9 is a schematic flowchart for another use of the HMI to control and monitor a process.

DETAILED DESCRIPTION OF THE EMBODIMENTS

Figure 1a shows display of an oil platform, a process for production or exploration etc for oil and gas. The display 1 comprises an oil platform 2, with one or more production areas 4, and a selection menu 5a. The display in this example is a 3-D model of an oil platform. The 3-D model displayed is a computer generated model that may be manipulated so that the oil platform may be viewed from different angles and at different resolutions or magnifications. Figure 1b shows a close up view of the same model of the oil platform 2, and Figure 2 shows a close up of process equipment on a part of the oil platform. Figure 5 shows schematically that the 3-d model is rotatable, for example about an axis 60 in a direction indicated by arrow 60.

The process equipment of the oil platform is monitored and controlled by a control system. The control system comprises information about the process, each stage of the process, and each separate equipment in the process. The information, real time, historic and documentation is stored accessible from the control system.

Figure 2 shows a display comprising the selection menu 5a, a tank 30, associated piping 34, a pump 33, a pump motor 32 and a pressuriser 31. Pressuriser 31 is shown to be marked in a particular way 9 shown here by a dashed ring. The image of pressuriser 32 is caused to flash and change colour, as suggested in the Figure by ring 9, representing by this feature of the 3-d model that an alarm about the pressuriser has been logged by the control system.

Such an alarm in a process may be handled as follows. A specialist or expert on the oil platform process has a display of the model showing the oil platform, as shown in Figures 1a,

1b or 6 etc. The display be a Macro view of the model of the oil platform rotating, thus showing a fly-around.

An alarm is signaled visually on the display and/or by a sound
5   signal; and the display automatically zooms-in through the 3D model to the specific device/location of the alarm. The expert selects to view the alarm description which has been logged by the software of the control system, which is further associated with control system software entities for the and
10   each specific device (for example a pop-up view when the expert right-clicks the image of the device 31). Figure 5 shows a display 1 zoomed-in to the process equipment including pressuriser 31, and a computer pointer device 40, a pop-up list 41 for the pressuriser. The pop up list preferably
15   contains a description of the alarm, title, device, nature of alarm, most recent occurrence, and so on. A similar method of use of the HMI is shown as a flowchart in Figure 8.

Figure 3a shows a display of the process section of the oil
20   platform in which process equipment pressuriser 31, pump 32 are shown, but the associated electrical system or piping is not shown. Figure 3b shows a display of the process section of the oil platform in which the piping 34 is shown, but some types of process equipment are not shown. The expert selects
25   two additional visualisation layers each in turn, piping 34 Figure 3b and components 31 etc in the 3-D model. By examining the information presented about the electrical, piping etc systems the expert can rapidly identify what has happened to cause the alarm, and what, if anything, ought to be done about
30   it now or later.

Figure 7 shows schematically a device, pressuriser 31, the computer pointer marker 40, and a group of operational facets stored in the control system and associated with the

pressuriser 31 that have been selected, so that the pop-up 41 is displayed. The expert selects eg right-clicks etc on different objects such as pressuriser 31, which results in activating a link or address so that associated device-
5 relative information such as trend curves, user manual, service history (e.g. from 800xA, a SAP, a SCADA system, physical location, process location, electrical schema, piping schema etc.) is available for viewing or retrieval. The expert selects a visualisation layer, for example People, and selects
10 a field operator located close to the pressuriser. He opens a communication channel, such as by picking up a phone, and a connection is set up automatically to the field operator.

Thus an expert or other qualified user may access information
15 rapidly via the interface comprising the model. The user may as described above in relation to Figures 3a, b, and c, add a layer of information or remove a layer of information, in order to examine the context of a device or process or of an alarm or other event from the device etc. Figure 8 shows in flowchart
20 form how a specialist or expert may use the interface to examine an alarm and gather current and/or historic technical information relevant to the alarm.

Figure 8 shows then a flowchart wherein an alarm is reported 81
25 on the display of HMI, an expert (or other user) selects to go to 82 the alarm and the HMI can automatically zoom in 83 on the part of the process where the alarm has come from. The expert can retrieve further information about the alarm by clicking on the alarm 84. The expert can record comments, 85 text, video
30 clip, animation clip, voice etc via the HMI. The expert may then access more information about the process part or device related to the alrm to obtain service history 86, trends, performance data, production data, manuals, other documentation and so on. The expert may then with access to any of the
35 information in the control system that is associated with the process alarm or device alarm make a judgement 87 and then, for example contact staff on site 88 or remote to investigate or

otherwise act.

Figure 9 is a flowchart showing another use of the HMI. An operator may switch from the process control system to the HMI.

5   For example as summarised, an operator gets a warning 91 on the control system. The operator reads the warning 95, and will obtain additional technical data. The operator switches 96 to the HMI and model and gathers, for example, an overview of other active alarms and events. After examining the other

10 information on current events, the operator may return to the control system 97, signs off that he/she has noted the warning, and records text, voice or other comments in the record for that component.

15 A 3-D model may be based on one or more CAD drawings of the plant or process. A 3-D or 2-D model may be based in part on electrical, piping or wiring schemas or layouts. A 3D or 2-D model is preferably layered, such that layers of information may be added or stripped. Such layers may represent functional

20 groupings such as electrical schemas, process flow, physical location, utilities and services (air, water) flow and so on. The model may be arranged for computer control for operations such as fly through, spinning, 3D viewing, zooming. The 3-D model is somewhat related to the computer generated virtual

25 reality developments, but applied to solving industrial problems.

Data points in the 3-D or 2-D model are associated with devices, sensors, nodes and so on that are connected to or

30 otherwise controlled by one or more control systems. The association may be arranged within one or more computer programs by using setpoints, by monitoring watchpoints, or by other means. The data may be arranged based on wire-frame data constructs with or without surface rendering techniques.

35

One or more microprocessors (or processors or computers)

comprise a central processing unit CPU performing the functions of the HMI and/or steps of the methods according to one or more aspects of the invention. This is performed with the aid of one or more computer programs, which are stored at
5   least in part in memory accessible by the one or more processors. It is to be understood that the computer programs carrying out methods according to the invention may also be run on one or more general purpose industrial microprocessors or computers, or on one or more specially adapted computers or
10 processors, FPGAs (field programmable gate arrays) or ASICs (application specific integrated circuits) or other devices such as simple programmable logic devices (SPLDs), complex programmable logic devices (CPLDs), field programmable system chips (FPSCs). The computer programs described may also be
15 arranged in part as a distributed application capable of running on several different computers or computer systems at more or less the same time.

A part of the program may be stored in a processor as above,
20 but also in a ROM, RAM, PROM, EPROM or EEPROM chip or similar memory means. The program in part or in whole may also be stored locally (or centrally) on, or in, other suitable computer readable medium such as a magnetic disk, CD-ROM or DVD disk, hard disk, magneto-optical memory storage means, in
25 volatile memory, in flash memory, as firmware, or stored on a data server. Other known and suitable media, including removable memory media such as Sony memory stick (TM) and other removable flash memories used in digital cameras etc, phones, or removable hard drives etc. may also be used. The
30 program may also in part be supplied from a data network 10, which may in part or temporarily comprise a public network such as the Internet.

In a further preferred embodiment, structured text documents

are used to link or provide references to the objects and control objects of the interface to objects and control objects held by the control system. It is necessary to connect 3D operator interfaces of the models to the control system
5   objects, such that the 3D interface can be updated with real-time information from the process plant (e.g. the 3D model-part representing the object starts blinking when the object is in an alarm situation). For this to be possible, there must be a link between the control system objects (such as the
10 real-time measurements from the distributed control system) and the 3D objects. It is important to find good methods for configuring 3D interfaces, otherwise the engineering phase will be much too costly because every single control system object must be connected to a 3D representation in addition to
15 the 2D representation, hence to make each link or reference by means of a manual configuration would increase the current engineering effort to a great extent.

Configuring the interfaces automatically can be done by using
20 a structured text format (such as xml, extended xml, caex, other industry accepted XML extensions) to connect the objects in a 3D model of the plant to the corresponding objects in the control system.

25 This is especially advantageous for those cases where part of the engineering is done in CAD-programs. In these cases there is an existing 3D model of the plant. Such 3D model or models can either be used directly or be used as reference for a 3D model that can be at used run-time. Both the linkage between
30 3D objects and control system objects as well as the location and orientation of each piece of equipment can be automatically entered into the structured text format from these models. Thus the information stored in the structured text format can be populated automatically from engineering
35 tools. Another advantage of use of structured text to link 3D

models to control object information is that it reduces the time and cost of configuring a system. Another advantage is that manual input errors associated with manually configuring links to the 3D model are eliminated.

5

In another preferred embodiment, controls for the CCTV systems commonly used in some industrial installations, such as oil and gas plants, may be integrated into the industrial control system. Thus it may be efficiently arranged to access a CCTV

10   system and display pictures and video images for an equipment, object or location by arranged the CCTV system as integrated into the industrial control system. Thus by operating a control means of the human machine interface or the 3D model described above, images from the CCTV system of an equipment,

15   object or location selected via the HMI or 3D model may be displayed: and/or CCTV or other cameras may be controlled by manipulating the 3D representation of the plant.

In other words, the 2D and 3D interfaces in control rooms can

20   also be used to control the video streams that are already available. There are currently several sources of video streams that are presented in the control room, and even more that will be available in the future. A known example is Closed Circuit TV (CCTV), which means video cameras that are

25   distributed throughout the plant for surveillance and overview purposes. Another example is wearable cameras that the field operators use in the field for improved communication with control room operators and remote experts. These video streams can be called up to view by selecting an object in the 3D or

30   2D interface and, for example, choosing to "View live video" of this object. This operation automatically selects the camera that can present this object (or alternatively, the best view if many cameras can view the object) and then manoeuvre this camera so that the chosen object is in view.

35

For example when an operator right-clicks an object in a process graphic he/she can choose to "view object in camera", which automatically presents a view of the object on a monitor. This involves an automatic system for selecting which
5 camera can be used to view the selected object (or which has the best view) and then manoeuvring the camera (pan/tilt/zoom) so the selected object is shown in view. Current CCTV systems have separate HMIs (most commonly these are separate hardware panels) from the rest of the control room equipment. This
10 occupies a lot of physical space in control rooms, is costly to develop, install and maintain, and it is difficult for operators to learn and handle many different HMIs and systems in time-critical situations.

15 Traditional CCTV systems have separate HMIs (most commonly dedicated hardware panels) from the rest of the control room equipment. The hardware panels interfaces occupy a lot of physical space in control rooms, are costly to develop, install and maintain, and it is difficult for operators to
20 learn and handle many different HMIs and systems in time-critical situations. Furthermore, the interaction with the cameras requires a great deal of knowledge of plant layout by the operator. When an operator wants to view a specific peace of equipment or a plant area, she must first select which
25 camera to use, then she must know the plant good enough to guide the camera to the correct pan/tilt/zoom setting to get the equipment into view. This is often done by a joystick-type control.

30 The limited effectiveness of known CCTV systems is a similar situation to that of the known audio systems. Today, control room operators, field operators, back-office personnel, remote experts and administrative personnel can communicate orally through telephone, mobile phones, UHF/VHF Radio systems and
35 Public Address and Alarm (PA & A) systems.

In another further preferred embodiment, such known audio system or systems in an industrial or oil and gas installation can be connected to the control system and the 3D
5   representation, such that these audio systems can be controlled by manipulating the 3D representation of the plant. Examples of such use can be to automatically dial a field operator by clicking on the avatar or symbol representing the operator in the 3D or 2D interface (and also selecting the
10   preferred communication means if more than one is possible). Furthermore, the operator can also select directly in the 3D interface which areas to dispatch a message over the PA & A system to. This can be very effective and powerful when combined with a 3D representation of a gas leakage, for
15   example.

In such a situation, information about which gas detectors have gone into alarm state combined with knowledge of escape routes and possibly also metrological information can be used to select which areas should be notified with the alarm
5   warning message. An advantage of generating this information from other (non audio) information accessed by the HMI or 3D model is that an operator may activate communications such as UHF/VHF transmissions or loudspeaker announcements for selected areas of the plant by the alarm or event affected
10 without having to have extensive or detailed location knowledge beforehand.

It should be noted that while the above describes exemplifying embodiments of the invention, there are several variations and
15 modifications which may be made to the disclosed solution without departing from the scope of the present invention as defined in the appended claims.

CLAIMS

We claim:

5   1.   A human-machine interface of a control system for
monitoring and control of a process, comprising:
        a computer generated model of said process displaying
said process or a part or component of said process, wherein
said model is arranged to map a point on the computer
10 generated model to data held by said control system about the
at least one part or component of said process.

2.   The interface according to claim 1, wherein said model is
arranged for manipulation by computer software means to change
15 the shape of the displayed image and generate a change in an
orientation of one or more selected parts of said model so
displayed.

3.   The interface according to claim 1, wherein said model is
20 arranged for manipulation by computer software means to change
the shape of the displayed image so and rotate said model or
selected parts of said model about at least one axis.

4.   The interface according to claim 1, wherein said model is
25 arranged for manipulation by computer software means to change
the shape of the displayed image and change the scale of the
one or more parts of said model so displayed.

5.   The interface according to claim 1, wherein said model is
30 arranged changeable with computer software means to present a
visual display comprising a zoom-in on, and/or zoom-out from,
one or more parts of said model so displayed.

6.   The interface according to claim 1, wherein said model is

arranged with computer software means to display, show or superimpose technical data or information from any part of said process on the display of the one or more parts of said model.

5

7. The interface according to claim 6, wherein said model is arranged with computer software means to provide an active link for accessing or retrieving technical data or information about any of the one or more selected parts or components of
10 said process displayed by said model.

8. The interface according to claim 1, wherein said model is arranged with computer software means to provide an active link for accessing or retrieving technical data or real time
15 information about a technical function of one or more selected parts or components of said process.

9. The interface according to claim 1, wherein said model is arranged with computer software means to provide an active
20 link for accessing or retrieving historical technical data or information about a technical function of one or more selected parts or components of said process so displayed.

10. The interface according to claim 8, wherein one or more
25 graphic components of said model are arranged with computer software means for displaying a plurality of groups of technical information grouped relevant to a selected function, location or other operational facet or of a selected graphic component.
30

11. The interface according to claim 1, wherein the one or more graphic components of said model are arranged with computer software means for displaying technical information relevant to a selected function, location or other operational

facet of the one or more parts of said process.

12.   The interface according to claim 11, wherein the one or
more graphic components of said model are arranged with
5   computer software means for displaying technical information
relevant to a selected one or more components in grouped into
a plurality of functions, locations, and/or operational facets
for the selected one or more parts of said process.

10   13.   The interface according to claim 1, wherein said model is
arranged displayed at least in part as a two dimensional
representation of said process, arranged for manipulation by
computer software means to so as to graphically change an
orientation of one or more selected parts of said model.
15

14.   The interface according to claim 1, wherein said model is
arranged displayed at least in part as a three dimensional
representation of said process, arranged for manipulation by
computer software means to so as to graphically change an
20   orientation of one or more selected parts of said model.

15.   The interface according to claim 13, wherein said model
is arranged for manipulation by computer software means to so
as to graphically change both scale and orientation of one or
25   more selected parts of said model.

16.   The interface according to claim 15, wherein said model
is arranged so as to graphically change both scale and
orientation of one or more selected parts of said model at the
30   same time.

17.   The interface according to claim 15, wherein said model
is arranged so as to change both one or more selected parts of
said model and display a moving image of said model in a mode

of any from the list of: fly through, spinning, 3D viewing, zooming.

18. The interface according to claim 1, wherein said model is
5   arranged for manipulation by computer software means to
superimpose a layer of information on top of the shape of one
or more selected parts of said model.

19. The interface according to claim 1, wherein said model is
10   arranged for manipulation by computer software means to remove
a layer of information from the shape of one or more selected
parts of said model and display other information about said
process.

15   20. A method to monitor and control a process using a human-
machine interface for a system for monitoring and control, the
method comprising:
         producing a model of said process with at least one
graphic element displaying one or more parts or components of
20   said process,
         selecting a point on the model, and
         mapping the point or data point on the computer generated
model to data held by said control system about the at least
one part or component of said process.
25

21. The method according to claim 20, further comprising:
         retrieving technical information associated with a device
or process displayed or represented by said graphic element
and
30   presenting the information on the display.

22. The method according to claim 20, further comprising:
         presenting for selection a group of information
structures holding operational data about different facets of

the at least one part or component of said process.

23. The method according to claim 20, further comprising:
        presenting for selection a list of information sources
structures holding real time or historic operational data
about different facets of the at least one part or component
of said process.

24. The method according to claim 20, further comprising:
        presenting on the display information of a warning or
alarm that has occurred in respect of the at least one part or
component of said process.

25. The method according to claim 20, further comprising:
        presenting on the display selection means (5) to receive
and or go to the warning or alarm that has occurred in respect
of the at least one part or component of said process.

26. The method according to claim 20, further comprising:
        manipulating the model to automatically go to the at
least one part or component of said process for which the
warning or alarm has been signalled.

27. The method according to claim 20, further comprising:
        manipulating the model to automatically go to the at
least one part or component of said process for which the
warning or alarm has been signalled.

28. The method according to claim 20, further comprising:
        manipulating the model to add or remove a layer of
operational information associated with the at least one part
or component of said process for which the warning or alarm
has been signalled.

29. The method according to claim 28, further comprising:

   manipulating the model to add or remove a layer of
operational information associated with the at least one part
or component for any from the list of: electrical system,
5 water/utility system, location of people, alarms, process
materials, fire and/or gas leakages

30. The method according to claim 28, further comprising:

   manipulating the model to display the at least one part
10 or component by means of any graphic operation or 3D modelling
operation from the list of: fly through, spinning, 3D viewing,
zooming.

31. A computer program which when read into a computer or
15 processor will cause the computer or processor to carry out a
method according to the steps of claim 20.

32. A computer readable medium comprising

   a computer program which when read into a computer or
20 processor will cause the computer or processor to carry out a
method according to the steps of claim 1.

33. A control system comprising a human-machine interface of
a control system for monitoring and control of a process,
25 comprising

   a computer generated model of said process displaying
said process or a part or component of said process, and

   a computer comprising a Human Machine Interface
comprising a model of said process arranged in that said model
30 is arranged to map a point on the computer generated model to
data held by said control system about the at least one part
or component of said process.

34. The control system according to claim 33, wherein the

human-machine interface comprises a model of said process arranged to map known set points in the model to data held by said control system about the at least one part or component of said process.

5

35. The control system according to claim 33, wherein the human-machine interface may be displayed and/or manipulated using a portable and/or wearable computing device.

10   36. The control system according to claim 33, wherein the known set points in the model are linked or referenced to data held by said control system about the at least one part or component of said process by means of one or more structured text documents.

15

37. The control system according to claim 33, wherein the structured text documents link control system objects to 3D model representations and their physical position/orientation.

20   38. The control system according to claim claim 36, wherein at least one structured text document is generated automatically.

39. The control system according to claim 33, further
25 comprising
        means for selection of a part of a human-machine interface or 3D object and to display one or more visual or video images of a selected object.

30   40. The control system according to claim 39, further comprising
        means for control of the video images from the control system.

41. The control system according to claim 33, further comprising

means for access to oral communication means with an operator by selecting a symbol of the a human-machine
5   interface or a 3D model control system.

42. The control system according to claim 41, further comprising

means for access to oral or audio communication means in
10   a given area of an installation by selecting or manipulating a symbol of the a human-machine interface or 3D model control system.

43. A human-machine interface of a control system for
15   monitoring and control of a process, comprising

a computer generated model of said process displaying said process or a part or component of said process, wherein said model is a 3-D model arranged to map a point on the computer generated model to data held by said control system
20   about the at least one part or component of said process.

44. Use of a human-machine interface of a control system for monitoring and control of a process, comprising a computer generated model of said process displaying said process or a
25   part or component of said process, for providing and presenting information in a control system of an oil or gas storage, treatment or process installation.

45. Use of a human-machine interface of a control system for
30   monitoring and control of a process, comprising a computer generated model of said process displaying said process or a part or component of said process, for providing and presenting information in a control system of an electrical generation, transmission or distribution installation.

46.   The control system according to claim 40, wherein the means for control of the video images from the control system comprises means to remotely operate pan/tilt/zoom controls of

5   a camera.

47.   The control system according to claim 41, wherein the means for access to oral communication means with an operator comprises a UHF/VHF radio or phone or portable phone.

10

48.   The control system according to claim 42, wherein the means for access to oral or audio communication means comprises oral or audio means, Public Alarm & Address devices, and/or loudspeakers.

15

ABSTRACT

A human-machine interface of a control system for monitoring and control of a process and including a computer generated model of the process. The process or a part or component of the process is displayed such that the model is arranged to map a point on the computer generated model to data held by the control system about the at least one part or component of the process. A method to monitor and control a process using the human-machine interface and a system including the interface are also described.